THE DIETARY OF THE SICK

THE KOUMISS CURE

VON ZIEMSSEN'S

HANDBOOK

OF

GENERAL THERAPEUTICS

IN SEVEN VOLUMES—VOL. I.

INTRODUCTION

BY

PROFESSOR H. VON ZIEMSSEN

ON THE DIETARY OF THE SICK AND DIETETIC METHODS OF TREATMENT

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TRANSLATED FROM THE GERMAN

BY

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PREFATORY NOTICE

TO

THE ENGLISH EDITION.

THE SERIES of volumes now offered to the English reader under the title of a 'HANDBOOK OF GENERAL THERAPEUTICS' is the first work of the kind published in any language.

Each Part, written by a German authority, eminent in his own department of practice, forms a Treatise complete in itself, dealing with the rationale and the applications of the Therapeutic Agent or Method which forms its subject-matter.

It will be noticed that several of the topics handled in the series have as yet received comparatively little attention at the hands of Medical Writers in this country, though their importance is becoming daily more fully recognised in the Profession.

The names of the Translators of the several Parts are a guarantee that the work of rendering the thoughts of the German Authors into accurate and readable English has been done thoroughly and intelligently.

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OF

THE FIRST VOLUME.

GENERAL INTRODUCTION.

THE plan of this 'Handbook of General Therapeutics,' which was intended to form a constituent part of that of 'Special Pathology and Therapeutics,' was determined on so far back as 1874. The books were to form a single whole: the survey of the state of General Therapeutics at the present time was to present the completion or complement of that of Special Therapeutics. Now that this programme has been completely carried out, and the 'Handbook of Special Pathology and Therapeutics' lies before us side by side with that of 'General Therapeutics,' it will not be out of place to discuss the question whether any serious exception can be taken to it either from a theoretical or from a practical standpoint. I am no friend to long prefaces, for it often happens that many things are promised in them which are not afterwards fulfilled; but it is otherwise with the review of a programme once laid down for the whole work, when that work is completed, and each component part lies open to the judgment of all. In this place, therefore, which is in a certain sense the keystone of the double work, I wish to say a few words.

No one can shut his eyes to the necessity that exists in our time for bringing together the works of the last decennium, rich as they are in details, in order to obtain a full view of the path that a laborious and unceasing activity in research has laid down. The history of every science has shown such times of recapitulation and calm retrospect. And a critical mustering and inspection

of our gains seems to be the more expedient, and indeed necessary, the more rapid has been the progress within a given period, and the greater the influence it has exerted on the development of the science. Through one such epoch of rapid progress has medicine passed in the last forty years. Not only has a vast mass of materials been collected as the result of research in matters of detail, but our views have undergone in many respects an almost complete transformation.

Clinical medicine has derived no small advantage from the development of science in general. Above all it has, by the introduction of the physiological method of research, acquired the right to march hand in hand with the other sciences, and with its sisters to take its place as a part of the science of man.

But, in order to secure a firm footing in this extended and in part newly acquired region, it is before all things necessary to review and examine what has been achieved; for we must know what and how much we can register as the certain property of the science. In Germany the first movement in this direction was the attempt so brilliantly inaugurated by Virchow to bring together in a collective work on General and Special Pathology and Therapeutics the experiences of numerous labourers in the several departments. Unhappily this remarkable work, which in some of its individual parts was epoch-making, remains unfinished. It has, too, unfortunately, in consequence of its incompletion, not experienced the correction and revision that the progress of the science required. So that in its seventeenth year, when we began our work, it had already become out of date. Now that all thoughts of the revision or completion of that work are out of the question, the necessity of a thorough review of our fast-growing possessions will be admitted on all sides, and not least by the clinicists themselves, and I have therefore determined to make the attempt of calling into being a Handbook of Special Pathology and Therapeutics as well as of General Therapeutics.

Since we now tread in the steps which our old master Virchow has hewn out for us in the loose rocks of corporate medicine we are enabled to avoid some of the difficulties and hindrances that brought his work to a standstill. Many impediments have already been removed by Virchow's own influence in the remodelling of medical theories, others through the rapid development of the collateral sciences, and some by the political regeneration of Germany itself. Want of inclination for a work of common interest, jealousies of schools or of individuals, indifference in medical circles, and parsimony in those who conduct the financial part of such undertakings are things which we have not met with since we took the work in hand.

If we have carried the division of labour further than Virchow did, we have thereby only a better opportunity of gaining a complete survey of the progress in every department, the vastness and weight of which a few shoulders could not have borne.

It is scarce worth the trouble to prove the need or the use of a division of labour in the fields of learning and scientific work. So long ago as 1854 Virchow, in the preface to his handbook, had urged in impressive language the importance—indeed, the necessity—of such co-operation. Though, here and there, some have been found ready to disparage the efforts of such learned associations, and the value of their combined exertions for this purpose, or to characterise them as unproductive labour, nothing could be further from the truth.

Fundamentally revisional works of this kind in the hands of eminent specialists become mines rich in ideas and springs of manifold encouragement to fresh work. Indeed, one may confidently assert that in the learned circles of Germany many an eloquent tongue would remain dumb, and many a treasure of knowledge and experience lie buried, were it not for the gentle compulsion of social organisation. The principle of division of labour pervades the spirit of our time; it is the

product of the rapid development of culture. The race of Polyhistors is extinct; nowadays it is no small undertaking for a single scholar to handle with equal erudition and soundness of judgment several branches even in his own special department of learning. So much the more evident is the necessity for a division of labour in greater and more comprehensive works covering the whole field of a science.

One thing, however, we must confess, is wanting in the works of such associations of scientific workers, just as in the reports of parliamentary committees and of special commissions in the departments of jurisprudence, of administration, and other branches of politics; something which only the work of a heaven-endowed individual can possess: it is that they do not emanate from one single source. This is the strong point of all opponents of co-operation in science as in art. We have had this charge brought against our work, and we cannot pronounce it altogether free from such defects. The manifold significance of facts, differences of opinion in respect of disputed questions, individual bias, and different ways of expression are incompatible with absolute unity in matter or in form. At the same time, ready as we are to acknowledge the shortcomings of our work, we are far from admitting that such divergences of opinion, various interpretations of facts, and differences of subjective judgment constitute any real defect. An apprehension and expression of scientific matters which reduces everything to one uniform level may be the outcome of a single mind, but it does not represent the actual state of things in our science. For what one investigator accepts as an irrefragable fact another holds to be an error, and what to-day is believed to be indisputably correct is set aside to-morrow by some new experiment. So long, then, as the most important principles of the science are contested, and the struggle of opinion sways to and fro, as is now the case in practical medicine, so long it can do no harm if the strife of theories makes itself apparent

in a work that professes to reflect the existing state of the science.

To the thoughtful physician it will be instructive rather than bewildering to find the *pro* and *contra* of each question in Ætiology, Pathology, and Therapeutics brought to the front, since he will thereby attain to greater certainty in judgment and criticism. Both judgment and critical power are indispensable to the physician who would grasp the fundamental theories of the causes and nature of disease, but a thousandfold more important is a ripe judgment in matters of therapeutics. No condition is more pitiable than that of the man who is a slave to the 'jurare in verba magistri' and who has with implicit reliance on the authority of another renounced his own judgment.

Our work is written for the well-educated and scientific physician. It is meant not merely to inform, but to suggest reflection and to prompt original work. And that it has attained its aim is amply proved by the numerous tokens of kindly acknowledgment which have welcomed it from all branches of the medical profession. Of greatest weight in this respect is the impartial judgment of the foreign medical press and the consequent translation of the work into other languages. We Germans seldom find complete satisfaction in our performances; we have always something to set right here and there, and, since there is nothing perfect under the sun, it is but rarely that our pleasure in our own work is unalloyed. So much the greater joy does it afford to him who gave the first impulse to the work to hear from competent and impartial voices abroad that German medicine may be proud of this achievement of her best authors.

Those comparatively minor defects of extent and form which still cling to the work, above all the dissimilarity of individual chapters in length and mode of treatment, will be reduced at each revision, and special care will be taken in future to remove the greatest fault, the overgrown bulk of single volumes.

In the 'Handbook of General Therapeutics' this last-mentioned defect has been avoided. Here the division of labour has not been carried so far as from the nature of the subject was inevitable in that of 'Special Pathology and Therapeutics.' The extent of each section is more moderate and the whole handier.

That a Handbook of General Therapeutics was a necessity scarcely calls for proof, since recent literature has no work to show which can be said to represent the actual state of general therapeutics in any thorough and comprehensive manner. It only remains to enquire whether the ground plan of this work answers the demands of our time. We will not conceal from ourselves the fact that the 'Handbook of General Therapeutics' too has many shortcomings, and will therefore let pass the objection that the division of the matter is wanting in logical sequence in so far as it deals with the therapeutics of the most important general diseases coordinately with the general methods of treatment. Our French critic ('Arch. de Méd.,' Fév. 1882) has not failed to call attention to this inconsequence, and finds the explanation in the fact that the faculty of logical arrangement of a subject is possessed by Germans in a lesser degree than by the French. Whether he is right in this point we will let alone for the present, only remarking that he misses the kernel of the matter when he holds the directive hand responsible for this arrangement, whereas it is the deficiency of materials that compelled it. The kind suggestion of the reviewer that a book may show a want of logical connection and yet contain many excellent things does not make his censure more palatable to us.

If we would attempt to lay down a scheme for a General Therapeutics in the future it is clear that, to correspond with the plan of General Pathology, it should embrace—

1. A general therapeutics of the general diseases (fever, inflammation, &c.)

2. A general therapeutics of localised diseases, or diseases of organs.

General methods of treatment might be discussed in a separate division, or be entirely relegated to the study of *materia medica.*

How much of this ideal is here realised, and how much is at present capable of realisation?

For the therapeutics of general diseases the postulate is fulfilled, so far as is possible in the present state of knowledge.

As regards the therapeutics of general disturbances of nutrition and general dietetic therapeutics, the attempt is made in this work to bring together for the first time the requisite scientific principles, so as to lay a broader and surer basis for this hitherto somewhat niggardly treated section of therapeutics. The unusual difficulties of such an attempt none can deny, and its worth will be rated so much the higher as it is felt to be an actual necessity in practice.

A general therapeutics of organs corresponding to a general pathology of the same as yet presents insurmountable difficulties, and has therefore been unattempted here. No doubt we have made great strides in respect of physical and chemical therapeutics. We have held such attempts justifiable with regard to particular organs, and have carried them out with satisfactory results. In our Handbooks of Special Pathology and Therapeutics such an attempt has been made for diseases of the upper air passages and the general integuments, we believe with success, and in the volume before us a general therapeutics of disorders of nutrition has been achieved. So, too, we consider, with regard to the general therapeutics of diseases of the stomach and intestines and of the bladder and genital organs. But when we go further we are met by insuperable difficulties. A general therapeutics of the heart, lungs, kidneys, the central and peripheral nervous

system would be practicable only in fragments. We would not, however, deny that even in this direction real progress has been made within the last decennium. We call to mind the possibility of influencing the rhythm and frequency of the heart's beats, the blood pressure and arterial tension, the amount of secretion in the renal parenchyma, the influencing of certain central apparatus of the nervous system—for example, of the reflex centres, of the vasomotor centre, of those of convulsions and vomiting, and of the centres for the secretion of the saliva and the sweat.

All this, however, is merely coming into existence; the clinicist must exercise the greatest forbearance; the field belongs first to the physiologist and the pharmacologist. What they have jointly accomplished in a relatively short time is of the highest importance towards laying the foundations of a scientific pharmacotherapy, and we venture to look with the greater confidence into the future since organic chemistry has in our days turned its attention more and more to questions affecting practical medicine.

It has contributed enormously to the advancement of pharmacodynamics, as well by the construction of new bodies as by exhibiting the active principles of the older recognised drugs as characteristic and definite chemical bodies. To this extraordinary productiveness of organic chemistry on the one hand, and to the restless endeavours of pharmacologists to ascertain the physiological action of the new-found substances on the other, clinical medicine owes such a profusion of new remedies that there is scarce time for testing them at the bed-side. And this is but the beginning of a new era for scientific pharmacotherapy! What a prospect is spread out before us if things go on at their present pace.

Practical pharmacotherapy has become altogether different from what it was thirty years ago; it is at once simpler in form and richer in materials. This is well seen by comparing the order lists of a clinical hospital in the 'fifties' with those of

the present day. An entire change has taken place, and, as every clinical physician will testify, a change for the better. The sphere of action of quinine, digitalis, squills, of the potash salts and boracic acid, &c., has been explained, and a long rank of new medicaments has been introduced whose physiological actions are well understood and of which the physician of to-day can scarcely dispense with one.

Such are chloral and bromal hydrate, bromide of potassium, thymol, salicylic acid, apomorphia, physostigmin, pilocarpin, amyl nitrate, chrysophanic acid, pyrogallol, &c. These are the achievements of scientific pharmacology in two or three decennia, achievements which outweigh the results of centuries of empirical observation in the same field.

If we lastly cast a glance on physical therapeutics, we find here an entirely new department, which, though cultivated by the exact method only within the last decennium, has already proved one of the most productive fields in therapeutics—hydrotherapy, electrotherapy, the mechanical treatment of diseases of the muscles and joints, of those of the air passages, the organs of digestion, urinary organs, &c.

At one time it was believed that in the therapeutics of the future the physical and surgical would supersede the pharmaceutical, but we must acknowledge that respectable progress has been made in every department, and that especially the development of pharmacotherapy and the fair beginning made in a scientific dietetotherapy may well compare with the progress attained in physical and surgical therapeutics.

We are very far from wishing to disparage our honest medical predecessors by comparing them with the investigators of our day; in genius, talent, and industry they are akin and equally worthy of honour. What we possess that they did not is simply the scientific method of enquiry which the empirical method repressed, and which is now beginning to do for clinical medicine what it did first for physiology. As pathology dates its present form from the moment when it recognised the

physiological method of enquiry, experiment, as the only sufficient method of research, so has therapeutics, since it set out on this path, remodelled itself, on the one hand testing by this standard its traditional lore and conquering new regions on the other. No doubt but pure empiricism, simple observation, or by whatever name one likes to call the old sources of the healing art, enriched our store of remedies with many valuable drugs, but through the scientific method only will therapeutics ever become a well-grounded or organically constructed work. Physics and chemistry, as they have been our teachers in physiology, so they are now in pathology and therapeutics also.

If therapeutics have as yet shared in a less measure than pathology and etiology in the acquisitions that the study of the diseases of mankind has made by this method, the reason lies in the greater difficulties that have to be surmounted here. It is precisely in respect of therapeutics that the results of experiments on the lower animals can seldom be accepted without subsequent confirmation on the human subject. There are, however, natural limits to experimentation on the human body itself, and when even one can take this position the conditions are so complicated and the phenomena so various that the result must often prove ambiguous and uncertain. Notwithstanding these difficulties, however, the experimental method has, by a judicious combination of experiments on the lower animals and observations on man, already achieved a positive basis for a scientific therapeutics which justifies the most sanguine expectations.

From these considerations we venture to assert that the pessimism which some of our most eminent physicians entertain with regard to therapeutics is not to be defended. In our experience practical medicine has never been further removed than at present from the tendencies to a crude empiricism which flourished along with the therapeutic scepticism of the thirtieth and fortieth years of our century. Let us

hope that the scientific method will never again be displaced from the dominant position it has begun to hold in practical medicine. A calm, steady development is to be secured only by refusing to abandon the firm basis of facts. A danger, however, if we mistake not, threatens in this direction from a too speculative tendency in pathology and therapeutics which has recently begun to develop itself out of modern theories on the causes of disease. Especially is the doctrine of the parasitic nature of infectious diseases, so attractive to speculative minds, likely to be pushed to the most extreme consequences. Let us hope that this fascinating current will not carry away with it more sober minds, that the easy spinning of hypotheses at the desk will not take the place of the more laborious search after facts in the laboratory, and that system-mongering will not again seize the helm. The past history of our science, which has already exhibited too many of such currents, and their disastrous consequences, will, we hope, suffice to guard us against another relapse.

In conclusion I turn once more to our Handbook, and at the completion of the double work of my honoured colleagues who have contributed their best thereto, return them the thanks of all those who have found our book a means of extending their knowledge, clearing their judgment, and encouraging them in their special work. I feel myself justified in so doing not only from my position of an intermediary rather than of a leader in this illustrious band of associated specialists, but also from the numerous letters of acknowledgment and gratitude that I have received during the last ten years on account of our book from both medical and scientific quarters. Unhappily we have in the course of our labours lost a number of our friends, proved champions of science and trusty companions in our common work. I need but name Bartels, Duchek, Friedreich, Lebert, Obernier, Schüppel, Steiner, E. Veiel, and Wendt to show what losses clinical medicine has suffered in so short a time.

I cannot omit returning my special thanks to one fellow-labourer, who, though nameless in the book, has taken a not less profitable and laborious share in the work. I mean Dr. Goldhorn of Leipzig. He is the author of a number of careful and accurate indexes to the separate volumes, which are so useful for easy reference.

Finally, every one of my colleagues will agree with me in heartily thanking the publishing firm of F. C. W. Vogel, and especially the honoured manager of the firm, Carl Lampe, LL.D., M.D., for his unwearied exertions in behalf of the work, and for the urbanity with which he has at all times and in the most effective manner smoothed the way, so thorny both to authors and publishers, in the execution of a work of such magnitude.

H. von ZIEMSSEN.

Munich, *March* 1883.

ON THE

DIETARY OF THE SICK

AND ON

DIETETIC METHODS OF TREATMENT

BY

PROF. J. BAUER, M.D.

INTRODUCTION.

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THE phenomena of life are connected with the constant consumption in the organism of matter which must be exactly compensated for by nutriment introduced from time to time if the material constitution of the body is to be maintained.

Under normal relations the essential problem of nutrition consists in the maintenance of that state of bodily equilibrium required for the performance of the functions demanded of it, and which is attained by the appropriate combination of various forms of nutriment. When, however, we have to deal with the nutrition of the organism in disease, the actual requirements are found to be far more complex and manifold.

The results of experience as to the influence on the organism of particular kinds of food, such as from an early period must have been evident to mankind, formed an essential part of the oldest medical practice. Thus among the ancient Indians, Egyptians, and Hebrews there existed recognised rules of diet, which were partly incorporated with the religious usages of these nations. The practice of medicine among the ancient Greeks gave an impulse to the cultivation of dietetics in many

ways, since in the gymnastic schools as well as in the temples of the Asklepiads a large mass of experience must have been accumulated. The philosophers too, and Pythagoras in particular, attached the highest importance to the regulation of life.

But it was with Hippokrates, who raised dietetics to the position of the essential and central feature of his therapeutics, that it first received a methodical cultivation. His general maxims no less than his special instructions were based on practical experience, and as such alike possess a lasting value. He held it necessary above all things to individualise each case, and to keep carefully in mind the previous habits of the patient. In febrile diseases he prescribed, as a rule, a restricted diet, but deprecated entire abstinence, and ordered a more liberal supply of nourishment with failing strength. The patients were to have an adequate allowance of drink, especially in the form of barley water, with a view to favouring the maturation and crisis of the fever. Hippokrates seems to have avoided the employment of milk in febrile diseases, but to have been well acquainted with the beneficial action of wine.

The doctrines regarding the qualities of the 'elements' held by the successors of Hippokrates gave great prominence to dietetics, but in their hands the study lost itself in subtilties and acquired a purely speculative character. Without any real knowledge of the several alimentary principles they arbitrarily enjoined certain combinations, and sought to remove hypothetical disorders of the humours by a corresponding selection of foods.

Chrysippus of Knidos, who borrowed nearly all his dietetic maxims from Pythagoras, and Praxagoras of Kôs introduced the hunger cure and other forms of abstinence. On the strength of their teaching Erasistratus prescribed fasting as the most efficient remedy in all febrile and inflammatory processes, which he held to be always dependent on plethora. In other respects he bestowed the greatest care on his rules of diet, in which he included also the preparation of the food.

Against the purely speculative tendencies of the dogmatics the empirical school called into existence a healthy reaction, which was of considerable advantage to dietetics in referring it

anew to experience. But, owing to their excessive reliance on drugs, the empirical physicians contributed little of a positive character to dietetics, although the most illustrious of their number, Heraklides of Tarentum, has left us a good medical work on the table.

In Rome there had been for a long time either no physicians or such as had no claims to the name. A few dietetic rules and a mass of superstitious expedients constituted the healing art of the ancient Romans. Greek medicine was transported to Rome by Asklepias of Prusa, who in his system of medicine referred all diseases to derangements of the atoms in the body. Fever patients for the first days of their illness were allowed neither food nor drink, though later on a liberal diet was enjoined, and the choice of food was left to some extent to the patient. Asklepias had a high opinion of the therapeutic value of wine, which he likened to the power of the gods.

The dietetic maxims of Asklepias gave place to those of the methodic school, the adherents of which laid themselves open to the reproach that in their instructions they attached the highest importance to reckoning the days of the disease and anxiously proceeded according to rule. A methodic named Thessalus introduced a 'regeneration' cure, which, notwithstanding the minuteness of its details, was devoid of all rational basis.

In the writings of Aulus Cornelius Celsus we find the dietetic teaching of ancient medicine emancipated from the intellectual yoke of systems. 'Optimum remedium est cibus opportune datus.' So reads an oft-cited apophthegm of this author. In febrile diseases he advised a spare regimen until failing strength should demand a more nutritious diet.

Aretæus of Kappadocia also laid down in a truly exemplary manner the treatment of all the more important forms of disease. His directions are marked not only by their appropriateness but by genuine Hippocratic simplicity. The use of milk was recommended by him with great earnestness.

The Hippokratic idea (*Schöpfung*) in the domain of dietetics was adopted by Galen in his system of medicine, although by no means free from an alloy of dogmatic dietetics. His dietetic maxims and teaching were esteemed as authoritative by his numerous imitators, but, as criticism and original observation

became extinct, they necessarily degenerated with the majority into empty and frequently misunderstood formulæ.

At this period, when medical science was fast hastening to decay, there were but few writers in whose works a single original thought or sound observation on dietetics can be found. Among these few Oribasius and Alexander of Tralles deserve special mention.[1]

The Arabian physicians pursued the study of dietetics with zeal, and advanced it perhaps more than they did any other department of medicine; the gain, however, was on the whole rather in the breadth than in the depth of the subject. Generally the Galeno-Hippokratic maxims remained in force, especially in the treatment of febrile diseases. In hectic fevers and in consumption the milk cure in various forms was much employed. Further, we find in several Arabian authors a multitude of dietetic rules laid down for all possible relations and conditions of life, and the most celebrated dietetic work of the Arabians contains elaborate disquisitions on all kinds of foods, the differences of which are determined by supposed elementary qualities extending even to the several varieties of flesh.

The Salernian school contributed thus much, that in the fresh revival they gave to medicine dietetics resumed the influential position that it had enjoyed in antiquity. At the same time the then prevailing scholastic method was of no advantage to the further development of medicine. Physicians composed prolix dissertations on the rules of life of Hippokrates and Galen, which in great part they knew only through the Arabians, and lost themselves in learned subtilties, as one may see in the writings of Gentilis of Foligno, Hugo Bencio of Siena, Bartholomæus Montagna, Mercurialis, &c.

These for the most part worthless efforts will explain how it was that Petrarca broke out in indignation on the subject when he exclaimed, 'A veritable tyranny has arisen out of dietetics, through which physicians arrogate a control in days of health nearly as great as that they exert over the sick entrusted to

[1] In the fifth century a physician of Constantinople named Jacob, though probably a charlatan, achieved no small reputation in consequence of his treatment of chronic diseases by a meagre and watery diet, whence he received the name of Psychrestus.

their care. History, however, teaches us that the Romans for over half a millennium knew how to live and to be healthy without any dietetic prescriptions. He who surrenders himself entirely to the dietetic rules of the physicians will never be well, and if this dieting is already ill-suited to the healthy how much more so must it be to the sick?'

The scholastic method was not altogether set aside by a more thorough study of the medicine of the Greeks; it was, however, no small advantage that recourse was once more had to the original. Among the Hippokratics who followed out the Kôan counsels for the treatment of febrile diseases in the true spirit of the master Jodocus Lommius may be mentioned.

The revolution in medicine, which in the sixteenth century overthrew the edifice of Galen after it had stood for more than a thousand years, opened up indeed new intellectual paths, but led only to various one-sided and fanatical systems, that not only neglected dietetics but left its bearing on therapeutics altogether out of sight.

The ideas of the Iatro-chemists and Iatro-physicists gave a real impulse to the physiology of nutrition and metabolism, but the knowledge of these subjects remained for a long time insufficient for founding thereon a rational dietary of disease. Any attempt, notwithstanding, could only end in errors of all kinds, whence many highly intelligent theoretics deemed it more prudent to remain true to the Hippokratic rules of life and to empirical observation.

The high value of dietetics as an aid to therapeutics was brought anew to light by that great practical physician Sydenham. The regulation of diet formed with him not seldom the sole and almost always an important factor in the cure of disease. In this respect we need not hesitate to class with him the most influential and conspicuous systematics of that time, especially Boerhaave and Fr. Hoffmann.

The system of the Englishman J. Brown exerted a somewhat retrograde influence on the principles of diet in disease, since he insisted in 'sthenic' diseases on limiting the supply of stimulants, under which he included every kind of flesh food as well as condiments and alcoholic drinks. In sthenic

pyrexia especially he allowed nothing nutritious, on the ground that the fever would be intensified thereby.

Broussais went even further, and under the despotism of 'gastro-enteritis' hunger cures rose to the rank of sovereign remedies. Only in the case of extreme weakness was any nutritious or easily absorbed diet prescribed. This withholding of nourishment was carried out by his zealous disciples with even more rigour and thoroughness than by Broussais himself, especially by Bouillaud, and many patients must have been sacrificed to his system.

The ill consequences of such a one-sided and extreme method could not long remain unrecognised, although in particular cases it survived to more recent times. With an extending knowledge of the process of nutrition in a state of health other views on nutrition in disease were little by little opened up; the researches especially of Chossat on inanition, and the experience of Graves and others as to the advantages of an intelligent administration of nourishment in disease, put a check to the extreme withholding of food.

THE AIMS OF DIETETICS IN DISEASE, AND OF DIETETIC METHODS OF TREATMENT.

The several problems presenting themselves in the dieting of the sick were recognised by the ancients and partly solved by them, so far, that is, as could be done with the help of experience alone. At all times, however, theoretical preconceptions have greatly influenced the practical treatment of disease, so that the very fundamentals of dietetics have undergone many changes, being accommodated to the systems in vogue for the time being.

The scientific basis of a system of rational dietetics could not be laid until the first principles at least of the processes of digestion and metabolism in the human body under normal and under pathological conditions were known. It is further necessary that we should have an adequate knowledge of the composition of foods and of the part played by each alimentary principle in the organism. These requirements are now to a

great extent fulfilled, thanks to the strides which our knowledge of the processes of nutrition has made since Lavoisier and Magendie, and even more since J. v. Liebig. Still, however, there remain many gaps in our knowledge of digestion and metabolism in the several forms of disease, and especially as to the action of particular articles of food and food stuffs in each. Experience is not equal to the solution of these problems in a satisfactory manner; recourse must be had on a far larger scale than hitherto to experiments, experiments in that direction especially which von Voit and von Pettenkofer have opened up for the healthy and diseased organism alike, and already with great success.

In the normal organism material effects are brought about by the ingestion of nourishment, which assume various characters, according to the amount and composition of the food taken into the body and also according to the proportion which the several food stuffs bear to one another; the actual state of nutrition of the body at the time has also a considerable influence. The like is true of the diseased organism, and the ideal problem of dietetics in disease would consist in being able to indicate for each individual case the food which in prescribed quantity and in definite combinations of the several principles should bring about in the body precisely those effects which appear to be called for in respect of the particular phase of the disease. In practice, however, the matter takes a very different form, since it is frequently impossible to introduce the kind of nourishment desired, or, if introduced, for the organism to utilise it.

Thus there are a great number of pathological processes in which, on the one hand, the capability of taking food, digestion, and absorption are more or less impaired, while on the other the waste of the tissues may be increased. Under such circumstances it is impossible that the reception of nutriment should keep pace with the waste, for nourishment would require to be introduced in such amount or in forms so ill adapted to the powers of the organism that much of it would never enter the nutrient currents and might lead to other and injurious consequences. This is especially the case in acute febrile processes, but very similar conditions may be met with in non-

febrile diseases when they involve any material changes in the organs of digestion.

Under such circumstances the withholding or restriction of nourishment becomes necessary until the disease has run its course, when the entire process of the restoration of the normal equilibrium has to be begun anew. When we have to deal not with an entire withholding, but with a restriction of food—a careful selection of the particular kinds being as a rule demanded—we have to consider how we may best make good the waste of body substance, at least in part, and at the same time bring about special effects in the body by means of the matters introduced. This last-named object is effected not only by the foods in the strict sense of the word, but also by the so-called 'accessory foods,' stimulants, &c. The various articles of food must, too, be given in such forms as shall not present any great difficulties in the way of digestion and absorption.

The withholding or restriction of food must never be carried so far that the advantages aimed at shall be outweighed by the dangers which prolonged inanition and wasting would entail. Especially in diseases of long duration must one be on one's guard that the waste of the materials of the body do not reach an alarming height without a timely and at least a partial replacement being effected. Besides the mere duration of the morbid process individual circumstances must be taken into consideration in each case, especially those of age, the previous state of nutrition, and, lastly, the capabilities of the organs of most vital importance, since the consequent inanition is directly influenced by these circumstances. In this respect the maxims laid down by Hippokrates for the management of fever cases are still as valid to-day as ever.

In other cases it appears desirable that the body should be maintained in its normal state of equilibrium. This demand involves no difficulty so long as the general condition and the nutritive processes in the individual in question do not materially deviate from the normal. The requirements of nutrition are, then, the same as in a state of health. It may, however, happen that the processes of disintegration in the body are being carried on in an abnormal manner, or that the ingestion and utilisation of nutriment are beset with unusual difficulties.

Under such circumstances, which are mostly met with in chronic diseases, if we would prevent the loss of body substance we must on the one hand adapt the nourishment to the special demands of the processes of disintegration, and on the other supply it in such a form as shall obviate the hindrances to its ingestion. Thus it happens that one may have recourse to ways and means which do not enter into the question of nourishment under normal conditions (artificial feeding). In such circumstances it is obvious that one cannot always entirely prevent this loss of body weight, and one must be content to keep it within moderate limits. In by far the largest group of cases the problem of nourishment consists in bringing about some change in the material constitution of the organism. As a rule this will relate to the restoration of those constituents of the body which have been lost through disease or some unfavourable external influences. In other cases it is some faulty condition of nutrition produced by an unfavourable habit, and in part a manifestation of an unhealthy constitution of body. In all these circumstances a restitution of the constituents of the body appears desirable, with a view to rendering the organism more capable of activity and resistance; and, lastly, there are pathological processes, for the completion and reparation of which an improved nutrition is absolutely requisite.

In other cases, and under certain circumstances, it is not a restitution but a reduction of the whole mass of the body, or a diminution of some one of its component parts, that is desired, either because these have accumulated in excessive amount or because in this way a favourable influence may be exerted on the course of the disease, as, for example, by the removal of morbid products. In such cases, therefore, a reduction of the general mass of the body is not to be looked on as an unavoidable consequence of the disease, but rather to be intentionally induced with a view to its cure.

The capacity of the body for the exercise of function is directly dependent on the presence of a corresponding amount of material for metabolism. But for the working off of this material a certain amount of activity is required. There is therefore for each individual a maximum limit, beyond which the supply of nutriment cannot be carried without injury.

There are, too, states of the body which render it incapable of much internal work, and in such it appears expedient to maintain the bodily equilibrium with a relatively small amount of nutriment. In the opinion of many authorities it not unfrequently happens that metabolism is conducted more slowly than usual, the products of an incomplete oxidation accumulating in the system if the supply of nutriment exceed a certain quantity; our knowledge, however, of such abnormal metabolism is still scanty. This much we do know for certain, that there are circumstances in which the elimination of waste products is impaired, so that from this point of view too it would appear that the supply should be restricted as far as possible.

The design of altering the general nutrition of the organism may often be realised by the preponderating employment of particular articles of food or food stuffs. If the idea of a process of regeneration of the entire mass of the body be involved in these dietetic or metabolic methods of treatment, the human body should in course of time be materially altered both as regards its constituents and their properties. This notion, handed down from antiquity, found a certain confirmation in the teaching of Liebig, according to which the whole of the so-called plastic materials in the food was employed in the building up of the tissues. On the strength of these considerations it was believed that by accelerating tissue change one could in a short time effect a regeneration of the entire body.

But the facts established by Voit show that the greatest part of the albuminoid constituents of the food are destroyed in the body without having previously entered into the composition of the tissues. We must also admit, on the cellular doctrine, that the properties of the living cells, in which those descended from them share, are not essentially altered by the fact of more or less material being offered to them for metabolism. This can occur only when, by a particular diet, an alteration is brought about in the material composition of a tissue, by which its functional activity and its power of resistance must together be affected.[1]

[1] On the general considerations that present themselves in the dieting of the sick compare also Fr. Renk, *On the Dietary in the City Hospital at Munich*.

The success of the several dietetic methods of treatment is assuredly not to be sought always and exclusively in a reduction or acceleration of metabolism, nor in the retention or elimination of the substances composing the body, since a particular dietary may exert great influence on the appetite, digestion, action of the bowels, and especially on the general feelings. Besides, other conditions, enjoined at the same time, as exercise in the open air and emancipation from work and care, must be taken into account.

The supply of nourishment to the sick must then be so regulated, both as regards quality and quantity, that the nutrient matters may be absorbed without deranging the organs of digestion, and that they may be enabled to set up in the organism such actions as appear consistent with the condition of health for the time being. Thus the sensation of hunger, by which under normal conditions the ingestion of food is regulated more than by anything else, though still an important indication, can by no means be taken as the sole guide, since it may be entirely absent or be abnormally expressed in other directions.

The qualitative requirements relate chiefly to a right choice of the various foods and to the form in which they shall be presented, and here we must not merely take into account their composition, their fluid or solid state, &c., but that they shall be as agreeable as possible to the taste and the other senses. The importance of stimulants and condiments is to be rated far higher in many conditions of disease than in health.

The quantity of nourishment to be administered is in the majority of cases estimated easily enough without taking account of weight and mass. In practice it is perfectly sufficient to know in what proportion the several alimentary principles are contained in each of the usual articles of food to be able to give directions sufficiently exact for the purpose. It is often of the greatest importance to make sure that at each meal time only a small quantity of food is taken into the stomach. In such cases the maxim 'Little and often' becomes applicable.

THE VALUE OF THE SEVERAL FOOD STUFFS, STIMULANTS, AND CONDIMENTS.[1]

THE human body consists mainly of albuminoid substances and their derivatives, together with fat, water, and mineral matters or ash. A certain proportion of its constituents is constantly being removed from the body by the processes of metabolism. To make up for this loss is the function of nutriment, which consists of various products of the vegetable and animal kingdom which we call foods.

Foods are very various mixtures of several chemical compounds, but those only of their constituents that are in a condition to replace or to increase the materials necessary to the composition of the body, or to check the elimination of the same, are actual aliments. As such we regard especially the albuminoids and gelatine, the fats and carbohydrates, water and salts. None of these alone will suffice to maintain the human

[1] [It is most unfortunate that we have no English word which can be taken as the equivalent of the German *Genussmittel*, comprising all those substances the primary if not the sole value of which consists in the pleasurable sensations they excite in and through the nerves of special sense and the central nervous organs, their nutritive properties, if any, being secondary and non-essential. They include alcohol, tea, coffee, vinegar, condiments and spices, salt and sugar, so far as used for flavouring. Etymologically 'stimulants' would not be inappropriate were it not already conventionally restricted to alcoholic drinks. 'Accessory foods' is a clumsy paraphrase, and 'luxuries' scarcely conveys the true idea, for though they are, as the German *Genussmittel* implies, means of enjoyment, they are in some form or other indispensable to the appetite.—TRANSLATOR.]

The value of the several food stuffs can only be briefly considered in the division of this book which treats of the feeding of the sick and of dietetic methods of treatment. A full survey of the literature of the subject and the discussion of disputed questions would stretch the chapter on the value of the several food stuffs far beyond the limits permitted by the aims of the book before us.

being, but each of them has a particular value in nutrition, and only by an appropriate combination of them all will the desired material results be attained.

Besides these foods proper mankind employ many substances which, though they cannot serve for the repair of the constituents of the body, seem none the less necessary to the processes of nutrition and the unrestrained exercise of the functions of the organism. These act on the several regions of the nervous system, partly in a direct manner and partly through the intervention of the organs of taste, and are described as stimulants or condiments (*Genussmittel*).

In the greater number of our articles of food the several food stuffs are far from being contained in due proportions, some being present only in small amounts, while on the other hand some are in excess. The single articles of food are therefore as a rule insufficient for nutrition, or they must be taken in very large amount if the body is for long to maintain its condition of equilibrium. An adequate diet always consists of a mixture of several articles of food in which albumen, fat, carbohydrates, water, and mineral matters, together with the necessary relishes, &c., must be contained in suitable proportions.

In all questions of nutrition it is necessary accurately to distinguish between nutriment, articles of food, food stuffs, and stimulants, &c. (*Nahrung*, *Nahrungsmittel*, *Nahrungsstoff*, and *Genussmittel*), in the above sense, derived from the definitions laid down by Voit, since countless misapprehensions cannot but follow if these expressions are arbitrarily used. In dietetic treatises especially must one observe a precise mode of expression, and never on any account employ such terms as give only a vague or a positively incorrect representation of the value of the substances under consideration. The expressions which are still to a great extent in common use refer either to the mere source of the articles of food in the vegetable or animal kingdoms respectively, to their external marks, their containing sapid substances, and so forth, or they are derived from certain and in part only conjectural actions of the same on the body, without the necessary regard to their chemical composition or physical effects. One must not content one's self with distinguishing between an animal and a vegetable diet, still less with speaking of a light, an unirritating, and a strengthening diet, of strong broths, and so on.

A definite hypothesis as to the value of the several food stuffs in the economy was first formulated by Liebig when he determined from the composition of the animal body what substances must be contained in the food; and, since the proteids appeared as the most important constituents of nearly all the organs, he ascribed to the albuminates a prominent *rôle* in nutrition.

Liebig further recognised in the processes of metabolism the only source of the functional activity of the organs, and assumed that the exercise of the same involved the consumption of a corresponding portion of the proteids out of which they were built. According to this theory the albuminoid constituents of the food were applied solely to the repair of the organs used up in work, whence they were distinguished as the plastic elements of the food in opposition to the fats and carbohydrates, which, supposed to serve merely for the evolution of heat, were on that account called the 'respiratory elements.' Consequently the albuminates were considered as exclusively the nutritive substances, and a nutritious diet and one rich in albumen became convertible terms.

The effects of the several food stuffs in the body can be studied only when one knows the influence which they exert on metabolism. Thus it has been proved by numerous observations that the amount of nitrogenous metabolism is essentially independent of the albuminoids contained in the food. This fact can scarcely be reconciled with the theory that the collective albuminoid constituents are wholly applied to the repair of the tissues used up in work. To avoid the contradiction between the results of observation and the supposition, then held to be irrefragable, that a corresponding portion of an organ was destroyed in work, the theory of the so-called 'Luxusconsumption' was proposed. According to this theory the albumen in the food replaced the loss of the albumen which the organs suffered in work. If, however, albumen were present in excess in the food it underwent immediate combustion in the blood, with evolution of heat, and could so far replace the fats and carbohydrates. The measure of the albumen which must necessarily be contained in the food was sought in the extent of nitrogenous metabolism in absolute starvation.

The theory of *Luxusconsumption* was demolished by the evidence first brought forward by Voit that nitrogenous metabolism is not influenced by the functional activity of the organism. It has once been shown that the quantity of albuminoids which a starving organism consumes is not enough for the continuous maintenance of life even if a sufficient amount of fat and carbohydrates be added. From a consideration of these facts it was clear that the theories as to the source of muscular power, the conditions of nitrogenous metabolism in the body, and the value of the albuminoids in nutrition must all undergo a complete revolution.

Voit showed conclusively from numerous observations that the albuminoid substances in the body undergo metabolism in different degrees according as they are formed into cellular structures or remain in solution, forming a principal constituent of the fluids which, constantly circulating as nutrient material through the living organs, are perpetually renewed by the act of nutrition. Under normal conditions only a comparatively small loss through metabolism occurs in the albuminous material of which the whole mass of the organs is built up, while the albuminates contained in the interstitial circulating fluids undergo rapid and extensive processes of splitting up through the action (*Wechselwirkung*) of the cellular structures.

Certain phenomena presented by albuminous metabolism in fasting force us to accept the position that the greater part of the albuminates which are daily subjected to metabolism in the body is taken from the circulating fluids and not derived from the structures of the organs themselves. If, for example, an animal be deprived of food, the albuminous metabolism in the earlier period of starvation manifests itself differently according as albumen has been previously supplied in the food in large or small amount. Thus Voit observed in a dog an elimination of sixty grammes of urea on the first day of abstinence following on a liberal flesh diet, while the same animal after a diet poor in albumen excreted only fourteen grammes of urea on the first day of abstinence.

With prolonged starvation those initial differences in albuminous metabolism which are dependent on the previous supply of albumen disappear, for the amount of nitrogenous metabolism in animals previously liberally supplied with albumen soon sinks to the lower point observed in those which had been poorly fed. In the animals the

subjects of the experiments above mentioned the elimination of urea after a previously ample provision of meat sank in the course of a few days' abstinence from sixty to twelve grammes, and then remained almost stationary for a long time. This rapid and remarkable diminution of albuminous metabolism during the early period of abstinence bore throughout no relation to the loss of body weight, for this fell at first much slower than the amount of metabolism, and, on the other hand, it proceeded much more rapidly afterwards, and therefore cannot be dependent on the total mass of the body.

If an animal after a previous liberal meat diet metabolises on the first day of abstinence five times the quantity of albumen that it does a few days later, while the body weight has obviously not been reduced at the same rate, the only conclusion that can be drawn is that on the first day of fasting a considerable amount of circulating albumen is still present from the previous feeding, and that this undergoes metabolism more quickly than the albumen of the organs. But the stock of the former is soon exhausted, and after the lapse of a few days the albumen of the organs, metabolised with difficulty, must serve for the maintenance of the vital processes, when the amount of nitrogenous metabolism speedily decreases. After a previous diet poor in albumen an animal possesses at the beginning of its fast no considerable stock of circulating albumen, and consequently the same conditions exist in its case from the commencement which in others well provided with albumen do not make their appearance until after several days of abstinence. The animal lives from the first by the consumption of its own organs, and so manifests throughout a low excretion of urea.

Again, a series of observations on albuminous metabolism during the administration of food support the view of an unequal participation in the metabolic processes by the circulating and organic albumen. Lastly, for a further proof J. Forster has shown, by experiment, that while in transfusion blood of the same species remains for a long time unmetabolised, albuminous solutions injected into the blood-vessels undergo immediate metabolism.[1]

The stability of organic albumen is subject to variation under the influence of pathological processes. Thus we know that in all febrile states albuminous metabolism undergoes an abnormal acceleration, and certain poisons, especially phosphorus, act in like manner. We must admit that under pathological conditions the normal connections of the constituents of organs are loosened, so that a certain amount of the proteids is liberated from the cellular tissues and submitted to metabolism. Doubtless through the consideration

[1] See the chapter on 'Transfusion' in this *Handbook*, vol. i. 2, 3.

that under pathological conditions the organic albumen may be, to a great extent, brought within reach of metabolism, the import of an abnormal increase in the disintegration of albumen (as shown by the excretion of urea and uric acid) is rendered easier of apprehension.

The fact already mentioned that albuminous metabolism in the body is to a great extent dependent on the ingestion of albumen accords with the assumption that it is mainly the circulating albumen that under normal circumstances is submitted to metabolism. One has but to imagine that the albuminates dissolved in the intestines mingle after absorption with those already present in the fluids, and circulate with them through the organs, while through the action thereon of the cellular tissues a great part undergoes certain splitting-up processes without having previously served any plastic purposes. Each accession of albumen induces an acceleration of albuminous metabolism, since this goes on more actively as more circulating albumen bathes the cells.

The supply of albumen, as Voit has pointed out, is by no means exclusively determinant of albuminous metabolism, this being in a far greater degree influenced by the previous state of nutrition of the organism in question. Each ingestion of albuminates must produce some alteration in the albuminous constituents of the body, while the amount of circulating albumen will be directly increased. This shortly interacts with the cellular tissues and is thereby in great part metabolised: the state of nutrition of the tissues stands in definite relation to the amount of nutrient materials supplied to it.

If day after day a like amount of albuminous matters be ingested with the food the state of nutrition of the tissues will remain unchanged, just so much albumen being metabolised as is contained in the food. But if the ingestion of albumen be augmented, then on the one hand we find an accelerated metabolism, and on the other a certain quantity of albumen retained in the organs and applied to the increase of the mass of the body. The storage of albuminous materials in the body continues, however, to take place only until the state of nutrition of the tissues becomes accommodated to the increased ingestion; a condition of equilibrium then succeeds, in which the income and expenditure exactly cover one another. In like

manner the organism possesses the power of adapting its albuminous composition and rate of metabolism to a reduced supply of albumen.

Obviously an upper and lower limit exist to the amount of albumen in the food with which an animal can maintain a constant weight. Too large a mass of albuminates will not be capable of appropriation by the organs of digestion, while with too little albumen in the food the body continues to yield it from its own organs until finally death follows through deficiency of albumen.

The activity of albuminous metabolism is dependent in normal conditions on the ingestion of nutriment on the one hand and on the previous state of nutrition of the organism on the other; the latter indeed determines whether a given quantity of albumen in the food exactly meets the requirements of the body or not, or whether there will finally remain an excess present in the organism. In this way one can explain the observation that the same amount of albumen in the food produces quite different results in one and the same individual, according to the different states of nutrition in which the organism happens to be at the time. The same amount of albumen that in an emaciated convalescent produced an accession to the weight of the body may another time be insufficient, to maintain the same man in good condition.

Albuminous metabolism in the bodies of animals may be indeed considerably modified by the use of other food stuffs, but can never be entirely suspended. Thus during the exclusive administration of fats and carbohydrates nearly as much albumen is used up as in absolute fasting, and even gelatinous substances are never capable of entirely preventing the removal of albumen from the body. Albumen is absolutely necessary for sustaining the vital processes, and is capable of being replaced by the other food stuffs only to a certain point; it exerts the greatest influence on the energy of the metabolic processes, since it easily undergoes a splitting up in the nutrient fluids and at the same time enables the living cells to break up other matters in larger quantities. The functional activity of the organism is also intimately connected with the presence of albumen in the food.

Albumen is the only food stuff which in the presence of water and the constituents of the ash can of itself alone support the vital processes. It can thus completely replace the fats and carbohydrates, while the reverse is not the case. At the same time pure flesh is not a suitable diet for mankind, because a disproportionate amount of it would be required to maintain the constitution of the body.

An adult man who with a mixed diet excretes 250 grammes of carbon and 18 grammes of nitrogen would require, in order to cover expenditure of carbon compounds, over 2,000 grammes of pure flesh, containing no less than 12·5 per cent. of nitrogen. The amount of nitrogen, on the other hand, contained in the expenditure would be fully met by 500 grammes of flesh, with a percentage of 3·4 of nitrogen.

One must not, however, suppose that a supply of albumen above what is just necessary for the maintenance of life is superfluous (*Luxus*), for the functional activity and resisting power of the organism seem to be essentially connected with the presence of an ample supply of albumen.

The Value of Peptones.—The albuminous matters contained in our food must as a rule be first reduced to a state of solution by the action of the digestive organs before they can be absorbed. But, since it is very often desirable in pathological conditions to call the digestive functions into play as little as possible, peptone, a product of the digestion of albumen, first suggested by Meissner, has recently been extensively employed as an albuminous aliment instead of the insoluble albumen. Thus the question, much discussed of late, whether peptone can fulfil all the functions of albuminous substances in the body, or whether a certain quantity of the unaltered albumen is always necessary, has acquired in some degree a practical significance.

After the discovery of peptone it was generally held that all the albumen in the food must be peptonised before absorption, in order that after absorption it might again be reconverted into that modification of albumen which is coagulable by boiling heat. Against this view Brücke has brought forward a series of arguments, and has expressed his opinion that only albumen taken in unaltered can serve for building up the tissues of the body, while peptone is not reconverted into ordinary albumen, and Diaconow has also asserted the same. Voit and I have in like manner shown proofs that dissolved albuminates are ab-

sorbed without being transformed into peptone, and Eichhorst, Czerny, and Latschenberger have obtained similar results.[1]

The proof that unaltered albumens are capable of being absorbed is of itself obviously insufficient for enabling us to form a definite judgment as to the destination of the peptones in the body and as to their function in nutrition. Besides one must remark that an increased excretion of urea appears after the administration of peptones in a manner analogous to that which follows the ingestion of unaltered albumen. One can only infer from this fact that peptones are subjected to metabolism and that a certain amount of albumen may be replaced by them; but that a reconstruction thereof in the body and a participation in the formation of the tissues take place is not to be assumed from this fact alone. On the contrary, Fick has endeavoured to prove from this fact that peptone is quicker and more easily metabolised in the body, and that for that reason it can serve only as material for metabolism.[2]

For the solution of the question as to the value of the peptones in nutrition only the knowledge of the chemical composition of these bodies can avail anything, and it appears from the conclusions of Maly and others that the peptones differ little from the ordinary albuminous bodies in their composition.[3]

Only the results of accurately conducted experiments in nutrition can be accepted as sufficient, and unfortunately in such there are numerous difficulties to be overcome. Experiments of this kind have been carried out by several observers.

A first experiment with peptones was performed by Plósz on a young dog. The animal in question was at first fed on milk, and then during a course of experiments extending over eighteen days, received an artificially prepared liquid food in which the albumen was replaced by peptone. Meanwhile the body weight of the animal

[1] E. Brücke, *Sitzungsber. der k. k. Akad. Wissensch.*, vol. xxxvii. 1859, and vol. lix. 1869; Diaconow, *Med.-chem. Untersuch. von Hoppe-Seyler*, part iii. 1867; C. Voit and J. Bauer, *Zeitschr. für Biologie*, vol. v. 1869; Eichhorst, *Pflüger's Arch.*, vol. iv. 1871; Latschenberger and Czerny, *Virch. Arch.*, vol. lix.

[2] *Pflüger's Arch.*, vol. v., and *Verhandlung. d. Würzburg. phys.-med. Gesellsch.*, ii.

[3] R. Maly, 'Die Entstellungen u. Verwirrungen in der Peptonlehre,' *Pflüger's Arch.*, vol. xx., where will be found a statement of other researches in this subject.

rose from 1,335 to 1,836 grammes, besides an increase in growth being clearly seen.[1]

In a further experiment Plósz and Gyergyai fed a full-grown dog, after a fast of several days, with a solution of peptone and a corresponding proportion of non-nitrogenous food for six days, and compared the amount of nitrogen contained in the ingesta and excretions.[2] The urine and excrement were not taken directly, but evacuated in the cage over a wire net beneath which a funnel was fixed. During the whole experiment 14·451 grammes of nitrogen were taken in by the animal, while only 13·463 grammes could be found in the excreta. The body weight gained 259 grammes.

At the same time as Plósz, and independently of him, Maly also conducted experiments on nutrition with peptones.[3] A pigeon was fed for some time with as much wheat as it required for its maintenance; then the wheat diet was partially replaced by an artificial food in which the fibrin peptone of wheat took the place of the gluten. The experiment was repeatedly conducted in such a manner that little by little from half to three-quarters of the wheat was replaced by peptone food; on some days the pigeon received only the artificial food. It then appeared that during the peptone diet the body weight increased somewhat, whence Maly inferred that the peptonised food was better utilised in the alimentary canal than was the wheat.

The result of these experiments was interpreted as showing that peptone fulfils in the organism all the functions of ordinary albumen, and is also applied to the formation of tissue. But, as Adamkiewicz had already pointed out, this conclusion is open to serious objections.[4] Adamkiewicz consequently submitted the question anew to experimental proof, and indeed sought by an exact control of the nitrogenous income and outcome to demonstrate that peptones administered in the food were actually retained in the body and were capable of being converted into flesh.

For this purpose a dog, after a fast of several days, was supplied with a food of known composition in which there was so little albumen that the animal constantly lost a small amount of flesh. After the balance of albumen had for some days become pretty constant such an amount of peptone was added to the original insufficient diet that a gain of albumen was by this time to be looked for, and this expectation was invariably realised in frequent repetitions of the experiment.

[1] P. Plósz, 'Ueber Peptone u. Ernährung mit derselben,' *Pflüger's Arch.*, vol. ix. p. 323.

[2] P. Plósz and A. Gyergyai, *Pflüger's Arch.*, vol. x. p. 536.

[3] R. Maly, 'Ueber die chem. Zusammensetzung u. physiol. Bedeutung der Peptone,' *Pflüger's Arch.*, vol. ix. pp. 585 and 609.

[4] A. Adamkiewicz, *Die Natur u. der Nährwerth des Peptons.* Berlin, 1877.

There is no doubt whatever that the gain of albumen observed in these experiments was conditioned by the addition of the peptones to the original insufficient diet. Since, however, the animal constantly received in its food unaltered albumen along with the peptones, one must not overlook the question whether it was actually a part of the peptones or of the unaltered albuminous bodies that was retained in the organism and applied to the gain. It is, indeed, conceivable that the peptones possess in a high degree the property of sparing the albumen in the body, and thus completely take on the *rôle* of the circulating albumen without being themselves available for tissue formation. On this supposition it would be quite possible to produce a gain of flesh by the administration of the quantity of peptones necessary for covering the expenditure, if in addition a small quantity only of unaltered albumen be contained in the food.

Adamkiewicz has himself admitted the validity of this objection, but he considers that it is set aside by the consideration that no increase in the excretion of phosphoric acid appeared when the animal experimented on received with an insufficient amount of meat so much peptone and fat that a gain of flesh ensued. Adamkiewicz proceeds on the supposition that the whole quantity of phosphoric acid contained in the peptonised foods must have been eliminated in the urine if these had been metabolised, and would not have been applied to increasing the weight of the body.

But these considerations cannot be accepted as proving satisfactorily that the phosphoric acid may not find other applications in the organism, although the combinations with which the phosphoric acid was introduced are submitted to metabolism. One can only, from the experiments of Adamkiewicz, conclude with certainty that through an addition of peptones to a previously insufficient diet an increase of body weight was obtained, a corresponding amount of phosphoric acid being at the same time withdrawn from the circulating fluids, as indeed must be the case in every increase of flesh; but whether it was the peptones or the unaltered albumen supplied along with them that were retained cannot be decided on such evidence alone.

In another series of experiments Adamkiewicz made use of the indican contained in the urine as a measure, connecting this with the fact that the quantity of indican in the urine is greater the longer albuminous substances are retained in the digestive canal, in order to prove that peptones are sooner and more easily absorbed than unaltered albumens. It thus appeared that the excretion of indican was much less during the administration of peptones than during feeding with a corresponding quantity of albumen.

It was also noticed in these experiments that with an exclusive employment of peptone and fat a certain amount of the nitrogenous

substance was retained in the body. But this observation was continued for only a single day, and it cannot be determined from the experiment whether the peptones were retained as circulating albumen or as a constituent part of the organs.[1]

From the results of recently published experiments the conclusion unanimously drawn is that the peptones do fulfil in the organism all the functions of the albuminous bodies, since they are again turned into coagulable albumen, so that the absorption of unaltered albumen appears at least not to be absolutely necessary. This conclusion does not, however, follow with cogent necessity from any experiments made known as yet, and the hypothesis that the peptones can entirely take the place of the whole amount of the nitrogenous materials of metabolism, without, however, being capable of organisation, still awaits justification.[2]

According to this last hypothesis an organism could with peptones alone, and combined only with the necessary non-nitrogenous food stuffs, be kept alive only for a limited, albeit a fairly long, space of time; but for its continued maintenance the addition of so much unaltered albumen as is necessary for the repair of the tissues would be required. At the same time it is not improbable that a given weight of peptone is perfectly equivalent for purposes of metabolism to an equal amount of albumen, so that its albumen-sparing action far exceeds that of gelatine.

It is clear also that the peptones, even if in further researches they should be found not to be available for tissue formation, may yet be very valuable nutriments for the sick, being capable of replacing albuminous nutrition for months together and presenting the manifest advantage of being easily and immediately absorbed. A relatively small addition to the

[1] 'Ist die Resorption des verdauten Alb. von seiner Diffusibilität abhängig, und kann ein Mensch durch Pepton ernährt werden?' *Virch. Arch.*, vol. lxxv. p. 144.

[2] Already in the year 1874 I began a course of experiments on the value of the peptones in Voit's laboratory, but was unfortunately prevented by other engagements from bringing these tedious researches to a conclusion. Dr. Feder has recently carried out in the same physiological laboratory a series of experiments which I know by a verbal communication from Prof. Voit tend to prove that the peptones are not available for tissue formation.

food of unaltered albumen would be necessary in order to obviate the waste of albumen in the body as well as to attain an increase of weight. All clinical experience in peptone feeding in the past is capable of the same interpretation.

The impulse to the metabolism of the albuminous matters in the body proceeds from the animal cells, and without any active co-operation of the oxygen, which enters only gradually into the products of splitting up. Pettenkofer and Voit have found that under certain conditions the total nitrogen of the food passes out again in the urine and fæces, while a part of the carbon contained in the albumen remains behind in the body. These investigators concluded from this that the albumen was split up in the body into a nitrogenous and a non-nitrogenous part, the latter having nearly the same composition as fat.[1]

Further observations have shown that fat represents a regular product of the splitting up of albumen, which, according to the conditions existing in the body, is further broken up into carbonic acid and water or is stored up in the organism.

In pathological states oxidation may be diminished and the albuminous metabolism notably increased, so that even the stable organic albumen undergoes metabolism in a high degree. In the opinion of A. Fränkel an increased destruction of tissue is directly induced by a deficiency of oxygen in the system. In such cases the greater part of the fat split off from the albuminous bodies is not further broken up into carbonic acid and water, but remains for the most part in the cells and lies among the residues of the same. This process is correctly described as fatty degeneration.

If flesh alone be given large quantities are required in order that nutrition and waste may balance one another. But if fat be added the demand for flesh is less, albuminous metabolism being reduced by the addition of fat to the food. The material effect produced in the system by a given amount of fat depends on the relative proportions in which albumen and fat are contained in the food; the previous state of nutrition of the organism also has its influence.

[1] According to Henneberg from 100 grammes of albumen 35·5 grammes of urea are parted off, while 12·3 grammes of water enter into combination with the remaining 66·5 grammes; and after the elimination of 27·4 grammes of carbonic acid 51·39 grammes of fat are produced thereby.

The opinion formerly generally prevailed that the activity of the metabolic processes in the body was dependent on the amount of oxygen inspired. Liebig too, who sought in mechanical exercise the cause of the destruction of albumen, advanced the proposition that the intensity of the combustion of the non-nitrogenous aliments in the organism was conditioned by the amount of inspired oxygen. According to this doctrine the easily combustible non-nitrogenous bodies combine directly with the oxygen and thereby protect the albumen from its action. But this explanation that the fat as a respiratory food arrests the oxygen, and by so doing reduces the expenditure of albumen, cannot be the right one, for the addition of fat to the food induces a lessened consumption of fat in the body, and with an exclusive administration of fat there is less of this aliment metabolised and less oxygen fixed than in fasting. Besides, in some circumstances the whole of the albumen in the food is metabolised in the body, and the fat is applied to increase of body weight, whence it appears that fat is broken up into simpler combinations with more difficulty than albumen, and is not the same easily combustible body in the organism that it is outside. The fact, too, that in an exclusively fat diet the loss of fat from the body ceases entirely, and in some circumstances fat may even be taken up while the albuminous metabolism is not appreciably affected thereby, points in the same direction.

It follows from several facts that the non-nitrogenous food stuffs are as little broken up through the direct action of oxygen in the body as is the albumen. These are also next split up by the action of the cellular tissues into simpler products, into which the oxygen enters little by little. Thus under the influence of fat less oxygen is taken into the system, because by it waste is lessened, and consequently less oxygen is abstracted from the blood by the products of metabolism.

Contrary to the behaviour of the albumens in the organism, the extent of fatty metabolism is independent of the ingestion of fat. Other influences therefore which are without action in albuminous metabolism assume here the highest importance. At the head of these stands the performance of work by the organism, during which the tissues destroy a notably greater amount of non-nitrogenous food stuffs than in a state of rest. Again, the action of the temperature of the surrounding air makes itself felt, since more carbonic acid is produced in

the cold and less in the warmth so long as the temperature of the body itself suffers no reduction.

The action of external temperature on the amount of non-nitrogenous metabolism assists those regulatory arrangements in the organism which, by controlling the escape of heat, keep the temperature of the body constant. According to the needs of the system more heat is produced in the cold and less in the warmth. But if the temperature of the body itself suffers a change the production of heat is influenced thereby in the opposite direction, for a less production of carbonic acid attends a fall of the body temperature and a greater production a rise. That the waste of albumen is also abnormally increased with elevation of temperature we have already stated, so that in febrile conditions the metabolism of all the constituents of the body is increased.

The influence exercised by the surrounding temperature on the metabolic processes in the organism is exerted probably through the intervention of the nervous system, especially by that of the sensory nerves, the excitation of which is demonstrably of decided influence on the production of carbonic acid.

The material effects of albumen and of fat in the system are in a certain sense opposed, for the former increases the tissue waste and secondarily the oxidation, while fat induces the opposite effects. The lessening of metabolism does not generate fat through the fixation of the oxygen present; we must rather suppose that by its presence the metabolic energy of the animal cells is lowered.

This action of fat is of special importance when we have to consider how best to attain an increase of the constituents of the body. With an exclusive supply of albumen only very small quantities of this substance can ever be retained in the body, for each accession of albumen to the food conditions an increase of waste until after a few days the balance between income and expenditure is again established. With a simultaneous administration of albumen and fat a less amount of albumen is on this account necessary to meet the material wants of the organism, and if it is present in excess the metabolic processes do not attain the same proportions as with a diet consisting exclusively of albumen, so that a larger portion of

the excess remains undecomposed in the body and adds to its weight.

From several observations we may draw the conclusion that the albumen, which under the influence of fat remains unmetabolised in the body, is for the most part associated with that of the organs, and behaves as regards metabolism like organic albumen. When, therefore, with a diet consisting of albumen, either exclusively or in relative excess, a certain amount of albumen is retained in the system, it is the mass of the circulating albumen that will as a rule be increased thereby.

As regards the antagonistic actions of albumen and fat, the material consequences of any given mixture of these two food stuffs depend not only on their absolute quantities but also on the relative proportions in which they enter into the nutriment and into the system.

If the body is to take on both flesh and fat the food must not contain too great an excess of albumen in proportion to the non-nitrogenous aliments, because it is the circulating albumen that is chiefly increased thereby. Great quantities of albumen with the addition of but little fat very frequently lead to the deposition of fat alone, since, owing to the active waste of matter thus induced, the whole of the ingested albumen is destroyed; only the hardly metabolised fat is in these circumstances usually augmented.

If albumen and fat enter into the food in proper proportions, an appreciable increase of these substances in the body may continue to take place during a considerable period, for the balance between income and expenditure in the system is but slowly reached. If now albumens are supplied in excessive amount, a small increase of albumen occurs as a rule for a few days only, since through the accelerated waste that condition of the body in which income and expenditure cover one another is reached in a short time.

Thus in a dog who was fed for thirty-two consecutive days with a mixture of 500 grammes of flesh and 250 grammes of fat Voit observed a gain in that time of 1,794 grammes of flesh without the nitrogenous equilibrium having been reached at the conclusion of the course. But when, on the other hand, 1,500 grammes of flesh and 250 of fat were administered, the equilibrium was as a rule reached in from three to five days, seldom much later, after which an increase of but 300 to 400 grammes was found to have taken place. These facts find a satisfactory explanation in the view that under the influence of a suitable amount of fat the superfluous albumen in

the food is for the most part stored up as organic albumen, while with a deficiency of fat the quantity of circulating albumen only is increased by an excess of albuminates. In the latter case an acceleration of the albuminous metabolism soon takes place until there ceases to be any superfluity of albumen in the food and the equilibrium is established. An increase of the mass of albumen in the organs involves, on the contrary, no considerable increase in the metabolism of albuminates, and still less if by the simultaneous addition of fat a one-sided augmentation of the total albumen is avoided. Under such circumstances the rate of metabolism can be maintained for some time at a lower point than the supply, thus providing the conditions for increase of weight.

The fat stored up in the body acts in like manner with the fat contained in the food, since it likewise lessens the waste of tissue and secondarily the oxidation. Thus we understand why abstinence can be longer borne by organisms rich in fat than by those poorly furnished with it, the former consuming less of the albumen of their organs. To this connection we may refer the observation that in animals who have stored up only a small supply of fat in their bodies the albuminous metabolism is notably augmented after long fasting—that is, when the scanty fat of the body is used up and the organism lives exclusively on the albumen of its own tissues. The stock of fat stored up in the body is moreover the cause why corpulent individuals, frequently continue to gain in bulk although they are not in the habit of indulging in food immoderately.

Similar or analogous actions to those of the fats have oftentimes been ascribed to glycerin, chiefly, indeed, on the ground of its physical properties and derivation. Experiment has, however, shown that the albumen-sparing actions of the fats do not belong to this body, for it raises the waste of albumen with increase of diuresis. Since glycerin in larger quantities is eliminated with the urine, it is, to say the least, very questionable whether it can effect any considerable saving of fat in the body.

The action of the carbohydrates agrees in many respects with that of fat; since they are, in like manner, capable of protecting from metabolism a certain amount of the circulating albumen and of assisting its transformation into organic albumen. The conditions of the destruction of the carbohydrates are by no means identical with those that obtain in

the metabolism of fat. Thus we know that the metabolism of fat in the body is independent of the supply of this aliment, and that an excess of it in the food invariably produces an accession of fat. On the other hand the carbohydrates, according to the experiments of Pettenkofer and Voit, are almost completely destroyed in the body even when they are administered in great excess. From this we may also conclude that probably no such passage of carbohydrates into fat, as was formerly generally assumed, takes place in the organism; at least such a transformation cannot as yet be proved. Since we nevertheless observe that the carbohydrates, when given along with albumen and fat, favour an increase of the constituents of the body, especially of the fat, this must be owing to the fact that the carbohydrates are very easily subjected to metabolism and thus protect the other food stuffs from destruction. When fat and carbohydrates coexist in the food the latter are always the first to be consumed, and when they are present in sufficient amount the consumption of fat in the body may be completely suspended. Again, in a diet of albumen and carbohydrates alone, without the addition of fat, a deposit of adipose tissue may take place, since that fat which originates as a product of the splitting up of albumen is withdrawn from further metabolism in favour of the carbohydrates and contributes to the gain.

The easy metabolism of the carbohydrates in the body must not be regarded as depending on their great affinity for oxygen; its cause is likewise to be sought far more in the properties of the animal tissues. On the supposition that the equivalents of the food stuffs have the same relation in the body as the quantity of oxygen necessary for their passage into the ultimate products of their destruction, it was formerly assumed that 240 parts of starch were of the same value as 100 of fat, because for the conversion of these proportions of the two bodies the same quantity of oxygen is necessary. According to Pettenkofer and Voit this assumption is incorrect, since experiment shows that in the living organism 175 parts of starch are in the material actions approximately equivalent to 100 of fat.

An increase in the constituents of the body, and especially of the albumen and fat, is greatly favoured by the action of the carbohydrates. If an increase of albumen be desired without a considerable addition to the store of fat, a

liberal allowance of albumen with relatively small quantities of carbohydrates must be provided. If, on the other hand, a substantial addition to the fat appear desirable, the food must contain less albumen and more carbohydrates with a fair proportion of fats.

As to the nutritive value of the gelatiniferous tissues, the most contradictory opinions have been held at different times, some having described them as peculiarly nutritious, while others have come by experiment to the conclusion that they are absolutely worthless. It has, however, been shown by recent experiments that gelatinous tissues are destroyed in the body, producing urea as the product of their metabolism, whence we must admit that gelatin should be considered as a true food stuff. From the researches of Voit, which have given us a still more exact insight into the value of gelatin in nutrition, it appears that it is decomposed in the body with great ease, and therefore may within certain limits replace and be a substitute for the albuminates. The small quantity of gelatin which is taken with the food is always subjected to complete metabolism within a short time, and the albuminous metabolism is thus diminished in proportion to the gelatin ingested. By the administration of gelatin very large quantities of albumen can be spared in the body, or devoted to increase of bulk, just as by the supply of fats and carbohydrates. The place of albumen in the food cannot, however, be entirely taken by gelatin, since a constant though small loss of albumen from the body still occurs even when as much gelatin is administered as the organism can dispose of.

The fact that the gelatinous substances in the food are speedily subjected to complete metabolism, and never contribute to growth, proves that these bodies are not available for the building up and repair of the tissues. And, since the tissues constantly lose a small fraction of their albuminous constituents, in an exclusively gelatinous diet a continuous loss of albumen must occur in the body, for gelatin is not competent to take the place of the used up proteid materials. On these grounds gelatin even with the necessary addition of fat and carbohydrates will not provide a complete diet, and to enable the

body to maintain its condition an addition of albumen is always necessary.

Voit fed a dog weighing 29·5 kilos. for 35 days with a daily allowance of 150 grammes of flesh, 150 of gelatin, 150 of starch, and 5 of meat extract, and observed that so long as the animal took the prescribed combination of food he nearly maintained his weight. But later, as is the rule in gelatin feeding, the food was partially refused, so that a somewhat greater loss of weight ensued.

On the other hand a dog weighing 25 kilos., who received daily 200 grammes of dried gelatin (with 30·45 grammes of nitrogen), 250 grammes of starch, 100 grammes of fat, and 12 of meat extract, but without the addition of albumen, died on the 30th day. On the 6th day of the experiment the animal began to refuse the food put before him, which was afterwards administered by force even when vomiting followed. After the 28th day the animal showed marked symptoms of illness, and the experiment was discontinued on the 29th day. The dog then received a mixed diet which he took greedily, but immediately vomited it again, and death took place the following night.

A post-mortem examination revealed no change in the organs which could account for death. Probably the exclusively gelatinous and non-nitrogenous diet led in the course of some time to alterations in the composition of the nutrient fluids which were incompatible with life.

The supply of gelatin induces also a small diminution in the metabolism of the non-nitrogenous matters in the body, so that this aliment does not precisely correspond in its action either with the albuminates or with the fats and carbohydrates.

As remarked already, gelatin is capable of replacing an appreciable portion of the albuminates in the food; but it has a far higher nutritive equivalent than albumen, since in the experiments of Voit 168 grammes of dry gelatin were found to have approximately the same effects as 84 of dry albumen. In 100 grammes of dry gelatin there are 17·3 grammes of nitrogen, so that in gelatin feeding much more nitrogenous aliment must be introduced into the body than in albumen feeding in order to attain the same end; and in harmony with these facts is the far greater elimination of urea in nutrition with gelatin. This excessive excretion of urea is, again, the cause of increased diuresis and of a great demand for liquid, which

becomes important when large quantities of gelatin are contained in the food.

An exact knowledge of the value of mineral substances appears to be of special importance in nutrition, since broths, the action of which is in many ways due to the abundance of the food salts they contain, play so large a part in the dietary of the sick. The food salts have been held indispensable not only to the building up and repair of the tissues, but also for the digestion and absorption of the other food stuffs, and other special effects have been attributed to them, especially in the fluids of the body.

From the researches of J. Forster it appears that, when deprived of the necessary salts, animals die after some time as surely as when albumen is withheld. At first the digestion and absorption of the food as well as metabolism proceed quite normally; only after a long time deficient secretion of the gastric juice and impaired assimilation of the food sets in. When the deprivation of salts is prolonged the animals become weak and prostrate, a kind of paralytic condition succeeds, and they finally die, although they have not lost materially in flesh and fat.

Not only are growth and increase in the constituents of the body impossible without the presence of salts, but for the maintenance of the *status quo* of the body the provision of a certain quantity of food salts is necessary, because not only does the body constantly part with its salts, but the loss of these involves that of the other constituents with which they are combined. These facts, however, do not permit us to decide what amount of salts must be contained in the food in order to prevent a loss of the same from the body, nor what effects are produced by an excess of salts.

Towards an answer to the first question the experiments of J. Forster give us no positive help, since they show that the mineral constituents liberated in the processes of metabolism are not excreted in the same way as the organic products, but are retained in the body as incombustible matters, and may possibly be reapplied to other uses.

A small elimination of mineral matters continues even during the administration of food as far as possible free from salts; and, indeed,

this appears to be so much the less the more salt-free food is taken in. But if an animal that has for some time been fed on salt-free food is allowed to fast, an increased elimination of salts sets in.

According to J. Forster the true salts of the body exist in firm combination with the organised structures and fluids, and as such cannot be excreted. But there is also a certain quantity of salts simply dissolved in the circulating fluids, those, namely, which were introduced in excess with the food and those set free by the metabolism of organic matters. A certain proportion of these salts is constantly being eliminated from the body; but if, while salts are withheld, aliments, especially albuminous substances, poor in salts, find their way into the fluids, and there meet the salts set free in metabolism, the latter are again taken up by them and enter into fresh combinations.

As a rule we take in with our food a far larger quantity of salts than is necessary for the replacement of those of the tissues. The excess is again excreted with the urine, and only when an increase of the body weight occurs is any large amount of salts retained in the body. The quantity of the earthy matters that the body actually needs for its repair is already present in due proportion in most of our articles of food, and any further addition of salts, above all of table salt, serves only to make the food more palatable—is, in short, a condiment. Whether, on the other hand, in certain circumstances and diseases an excess of earthy matters in the food may not be desirable and useful we have as yet little means of knowing.

As to the consumption and elimination of earthy matters in pathological states, but few positive facts are at present known. To these belong the lessened elimination of chlorides in several, especially inflammatory, diseases, as well as the increased excretion of potash in fever, which latter apparently goes hand in hand with the augmented waste of tissue. In contrast to these processes of disease, in which the abnormal behaviour of the earthy matters is only of subordinate importance, Garrod, and others after him, have associated the origin of scurvy with a deficiency of potash salts in the food.

Since, however, all cases of scurvy can by no means be referred to a deficiency of potash salts in the food, Immermann has given a general countenance to the hypothesis of Garrod, pointing to a want of potash salts in the tissues as the originating cause, by which trophic disorders are induced, whether the deficiency of organic potash

be caused by an insufficient supply or in any other way. With this view the observation of Duchek, who, during the exacerbations of scurvy, found the urine relatively rich in potash salts, is in entire agreement.

The fact that deprivation of salts does not produce symptoms of disease in animals until after a considerable time, since the normal organs retain and use their salts over again, furnishes no argument against the admissibility of Garrod's hypothesis; and as little does the circumstance that as yet symptoms resembling those of scurvy have not been produced in animals by withholding food salts prove anything against it. It must, however, remain very doubtful whether in those diets which have been found by experience to develope scurvy so little potash salts were actually taken as not to meet the very small demands of maintenance.

The question whether a reduction of the potash salts in the organs lies at the foundation of scorbutic derangements of nutrition or not must in the future, as Immermann justly remarks, be brought nearer to solution by researches in respect of the earthy constituents of the organs. At present, in the choice of articles of diet for the prevention and cure of scurvy, regard must be had to their richness in potash salts.

To the inorganic aliments belongs also water, which makes up the greatest part of the total weight of the body. It renders possible the solution of other matters and the communication between the several regions of the body, and takes a direct share in the building up of the tissues. By the skin and lungs, as well as by the several excretions, the body constantly gives off considerable quantities of water, which must be again replaced by imbibition. Since the amount of water given off is influenced in a high degree by various circumstances, the demand of the organism for fluids is variable, being mostly dependent on the bodily heat and muscular work, on the temperature and humidity of the surrounding air, and on the kind and quantity of the solid food. The replacement of the water given off from the body is effected partly by various water-holding articles of food, and partly by drinks, of which water and alcoholic beverages call for special consideration.

Drinking water always contains a certain proportion of gases and mineral matters in solution, which together with a certain temperature render it palatable. The salts may also be applied to the building up and repair of the tissues. To discuss in detail the properties

of a good drinking water, as well as the injurious consequences that may follow the use of a bad one, does not belong to the plan of the treatise before us.

Alcoholic drinks combine with that of compensating the loss of water from the body several further actions. Alcohol is to a small extent eliminated unchanged by the skin and lungs, as well as by the kidneys; the greater part, however, is transformed into carbonic acid and water. The increase of albumen suffers thereby no appreciable change; that of fat, on the other hand, is reduced by small quantities of alcohol, while by very large doses it is increased, at any rate in animals. Alcohol also, in consequence of its metabolism and of its fat-sparing action, behaves in the character of a food. In several of our alcoholic drinks the nutritious effects are also heightened by the presence of small quantities of other food stuffs, as sugar, &c.; and it is easy to understand how these, when taken habitually in large amount, may lead to an excessive accumulation of fat in the body, since their effects, though individually small, mount up to a considerable total.

The great importance attaching to alcoholic drinks is, however, in no way dependent on any value they may possess as foods; they stand in the first rank of stimulants and luxuries, and as such are well-nigh indispensable, especially in many forms of disease.

The demands of the system for water are under normal conditions indicated by the sensation of thirst, which makes itself felt not only in inspissation of the fluids of the body, but also in dryness of the throat and in certain irritations of the mucous membrane, as, for example, that caused by many aromatic substances. In pathological conditions, too, the thirst is a measure of the needs of the system, which are very often augmented in consequence of the increased loss of water. Yet it not unfrequently happens that with deficient sensorial activity the feeling of thirst is not perceived, or at least not expressed by the patient, while in some cases intense thirst may be present as a nervous symptom without any increased necessity for fluids.

If the loss of water from the body be not, or but insufficiently, compensated, the tissues and fluids of the body suffer from want of water, and if it be carried much further a series of grave disturbances in the animal economy set in. These are especially marked when the body has lost a large amount of water

in a very short time; the consequences are then an insufficient circulation of the blood, an imperfect distribution of heat, and the retention in the body of the products of metabolism.

When water is ingested copiously a corresponding increase of the urinary secretion follows, since the blood-pressure is raised, and with it the activity of the kidneys; at the same time albuminous metabolism is accelerated, the greater amount of water in the tissues leading to a more active circulation of the fluids.

The quantity of drink the sick should receive must in general be adjusted to the loss of water from the body and to the sensation of thirst; but when the sensorium is dulled the requisite amount must be administered to the patients without any expression of desire on their part.

Under other circumstances it appears desirable to limit more or less the supply of liquids, as in defective absorption on the part of the stomach and intestines, or in irritable states of these viscera; and the absorption of abnormal collections of fluid in the body may be aided by withholding liquids. Again, in several morbid states overfilling of the vascular system and any considerable elevation of the blood-pressure must be avoided, and it would appear advisable that such persons should take as little drink as possible.

A liberal supply of liquids is especially indicated when by this means one may induce a free circulation of the fluids in the tissues, and wash out from them as it were certain effete matters. Copious potations may also exert some influence on the activity of the digestive canal, and the abundant diuresis that follows seems at times desirable in order to flush out, if possible, the urinary passages and to avoid their irritation by the concentrated urine.[1]

Besides foods properly so called mankind are in the habit of partaking of a considerable number of substances which serve neither for the repair nor the growth of the constituent parts of the body, nor are directly necessary to the maintenance of the vital processes. These are the so-called stimulants, condiments, &c. (*Genussmittel*), which exert actions of the most diverse kinds on the nervous system, and are therefore of the most extensive application not only in health but even more in disease. To this class belong the various sapid substances which are either

[1] A discussion of the various effects induced by drinks in virtue of their temperature, &c., does not come within the scope of this work.

contained in our articles of diet or are evolved from them in their preparation, besides flesh extract, coffee, tea, chocolate, condiments and spices, table salt, alcoholic beverages, &c.; also such substances as, for example, sugar, which, though of the nature of true foods, serve at the same time as stimulants through the sense of taste.

A large proportion of these exert a powerful influence on the activity of the organs of digestion, and through these on the general well-being, since they either excite pleasant sensations in the organs of taste or smell, or in some way stimulate the nerves of the digestive canal itself, or, finally, after their absorption into the blood react on the function of digestion.

Voit, in his treatise on the use of stimulants, has illustrated by numerous facts and daily observations the importance of many forms of nervous influence on the activity of the digestive organs. Agreeable mental impressions, especially as regards the taste of food, are indisputable aids to the appetite and to the perfect assimilation of nutriment. An insipid diet is rejected with disgust by man and beast, and food taken unwillingly is as a rule ill borne. With the sick one has frequent opportunities of observing the important part played in digestion by the nervous system, and especially by the sense of taste, not only the want but even the monotony of tasty substances being calculated to produce repugnance and vomiting.

These phenomena are in part at least easily intelligible, since we know the influence exerted by excitation of the terminations of the nerves of the mucous membrane of the alimentary canal on the digestive secretions and the peristaltic movements. We must further admit that direct and reflex excitation of the organs of digestion may be transmitted from the centres and from other parts of the nervous system; and it is clear that there exist numerous paths of nervous influence, through which the several organs of the body are in mutual relation with the digestive apparatus.

Mankind have learnt by experience countless ways of preparing and combining the various articles of their food so as to obtain a due admixture of the several alimentary principles, and at the same time to secure that variety of flavour which is an undoubted necessity. An absolutely monotonous diet, even if it fulfilled every other requirement, would soon become intolerable.

Another class of these substances exert no influence on the

process of digestion, but excite after their absorption into the blood various agreeable and beneficial stimulating effects on the nervous system, which produce either a sensation of comfort or a capacity for higher exercise of function. This increase of functional activity of the several organs, and especially of the heart, which a number of these substances are able to effect immediately, gives them an extraordinary value in the treatment of the sick. In consideration of the above-named actions these bodies are distinguished as stimulants.

THE MORE IMPORTANT ARTICLES OF FOOD AND LUXURY.

For the attainment of any given material result in the body a mixture of the several food stuffs in certain definite proportions is essential, and such is rarely to be found in any single article of food. The proportions required in each individual case are only to be obtained by appropriate mixtures or combinations of these, and in so doing we must be guided by a knowledge of the proportions in which they are present in each kind of food.[1] At the same time it must be remembered that under ordinary conditions equal weights of the same food stuffs may be of very unequal value, according to the kind and form of the food in which they are contained ; 100 grammes, for example, of albumen contained in black bread or potatoes are certainly not of equal nutritive value with 100 grammes of albumen in the form of flesh or of milk. In the dietary of the sick a still higher importance attaches to those differences among several articles of food which consist partly in palatability and partly in the ease with which they are digested and utilised in the alimentary canal. In the majority of cases it is comparatively easy to obtain any required admixture of the food stuffs,

[1] Numerous analyses are extant showing the composition of the principal articles of food and luxury. It was a most meritorious undertaking of J. König carefully to collect the more recent statements bearing on the subject from various sources, and to complete them by his analyses. I shall here content myself by quoting for the most important articles of diet the mean numbers given by J. König, and by referring my readers to their author for more exact statements and for the literature of the subject.

but if this is to fulfil every requirement those articles of food only must be included which present no difficulty in digestion and utilisation, and such also must be agreeable to the taste.

The food of man is partly of animal and partly of vegetable origin.

Animal Foods.

Foods derived from the animal kingdom are distinguished by the large amount of albuminous and sapid matters they contain; besides experience and observation have taught that they are for the most part more easily and completely digested than is the case with the majority of foods from the vegetable kingdom.

The most important of animal foods is the flesh or muscle of various animals.

Flesh is an aggregate of several tissues in which are contained, besides the proper muscular elements, blood vessels and nerves, also varying quantities of connective and elastic tissues and of fat.

Pure muscle consists on an average of 76 per cent. of water and 24 per cent. of solid constituents. To the latter belong the several albuminous and allied substances, besides a number of extractives partly known and partly unknown, as kreatin, kreatinin, carnin, xanthin, hypoxanthin, lecithin, &c., also some carbohydrates and a variable amount of fat, and, lastly, the so-called ash or mineral matter.

Albuminates constitute about 20 per cent. of fresh muscle free from fat; these are present partly in the soluble, partly in the insoluble state. To the former belongs myosin, which coagulates spontaneously after death. It is insoluble in water, but soluble in a 5 to 10 per cent. solution of common salt, also in dilute potash or hydrochloric acid, and is converted by the last-named reagents into alkali albumen and acid albumen respectively. A further coagulation of the myosin ensues on cooking, in which it assumes the properties of all albumens coagulated at boiling point. The other albuminates present in muscle in a state of solution are from a quantitative point of view of subordinate importance; one only, identical with the serum albumen, exists in somewhat larger proportion. To the dissolved albumens belongs also the colouring matter of muscle, possessing similar properties with those of hæmoglobin. Little is known as to the insoluble albuminates of muscle.

To the accessory constituents of muscle belongs a certain quantity

of invisible or mechanically inseparable fat, which is present in considerable amount in the flesh of fattened animals. The fatter the meat so much the less water does it contain, but the percentage of albuminates is also somewhat reduced.

With the death of the animal a number of changes set in in the muscle, which are termed *rigor mortis*; the most important of these alterations is the change of the neutral or amphoteric reaction of the normal muscle at rest into an acid one, which follows the transformation of the muscle sugar into lactic acid and causes the coagulation of the myosin. The advent and duration of the *rigor mortis* present great differences in different animals, but external conditions, especially the temperature, exert considerable influence. Flesh is, as a rule, not eaten until the rigor has passed off as a result of further changes, since it is then not only more tender but it seems to be more palatable than in the fresher state.

Quantitative analyses exhibit by no means inconsiderable differences in the composition of the various kinds of flesh, consisting chiefly in the relative proportions of water and of fat. In ordinary life the value or quality of meat is estimated with regard to its flavour and the tenderness of the muscular fibre and intermuscular connective tissue. In this respect there are not only well-marked differences in the flesh of different animals, but the age and sex and state of nutrition, as well as the part of the body from which the sample is taken, have to be taken into account.

If, then, we have to choose between the various kinds of meat with a view to the dietary of the sick, it is very difficult to lay down general indications whereby their digestibility and tolerance can be measured; but in all cases we must have regard to the tenderness and flavour of the meat and to the proportion of fat it contains, for the arrangement and distribution of the latter, as well as the relative proportion of the several kinds of fat, appear to have an influence in its digestibility and toleration by the patient.

By far the greatest part of the flesh consumed by mankind is furnished by the ruminants, foremost among which stands the ox.

The best beef is that from well-fattened oxen in the fourth and fifth years; cows too of that age give good meat. The flesh of older animals of either sex is tough, and that of bulls has in addition a very characteristic odour.

The condition or state of nutrition of the animal when slaughtered makes a considerable difference in the quality and composition of the flesh.

The following figures show the composition of several kinds of beef as they were delivered from the butcher :—

	Water	Nitrogenous Matters	Fat
Flesh of a very fat ox . .	54·76	16·93	27·23
,, ,, moderately fat ox	72·25	21·39	5·19
,, ,, lean ox . . .	76·61	20·61	1·50
,, ,, fat cow . . .	70·96	19·86	7·70
,, ,, lean cow . .	76·35	20·54	1·78

The flesh of the same animal shows marked differences, both as regards its composition and tenderness, according to the part of the body from which it is taken; lean and moderately fat joints are preferred by most as the best flavoured and tenderest. In France and England the flesh from different regions of the body is differently priced according to its quality in a way worthy of imitation. In England the flesh of the ox is divided into four classes. The first class includes the rump, sirloin, forerібs, haunch, and leg; the second class the upper and under loin, mouse buttock or calf piece, middle rib, and shoulder or leg-of-mutton-piece; the third class the flank, shoulder, brisket; and the fourth the cheek, neck, and shin.

The following table, which represents the composition of the several joints of a very fat ox, will show how greatly these differ among themselves :—

	Water	Nitrogenous Matters	Fat
Neck	73·5	19·5	5·8
Loin	63·4	18·8	16·7
Shoulder	50·5	14·5	34·0
Hind quarter	55·01	20·81	23·32
,, streaky . .	47·99	15·93	35·33
Fore quarter, lean . . .	65·05	19·94	19·97
,, streaky . .	32·49	10·87	56·11

Beef fat is composed of glycerides of the fatty acids in the proportion of three of stearic and palmitic to one of oleic. The melting point ranges between 41° and 50° C.[1] The fatty deposits in different regions of the body present slight differences in composition; the lowest melting point is that of the muscles and omentum (J. König).

[1] [Butter being about 32°.]

Veal, as is well known, differs essentially in taste from the flesh of the adult animal, and is described by many as being tougher and harder of digestion. This notion is naturally suggested by the fact that the flesh of very young calves, i.e. those that have been slaughtered a few days after birth, or at any rate within the first four weeks of life, shows, when minced, a certain adhesiveness and tenacity, plainly owing to the still embryonic condition of the connective tissue and to the proportion of gelatinous substances being somewhat greater than in beef. One is, however, scarcely justified in assuming from these properties alone that veal is the less digestible; on the contrary, the fibres are tender, and experience bears testimony to its being well borne by enfeebled digestive organs—more so, indeed, than beef. On an average the flesh of calves is richer in water, and on that account poorer in albuminates and fat, than that of adult oxen.

The composition of veal is seen in the following table:—

	Water	Nitrogenous Matters	Fat
Lean veal	78·82	19·76	0·82
Fat "	72·31	18·88	7·41
Neck of fat calf . . .	75·22	17·53	6·18
Breast	69·66	21·15	7·42
Loin	76·25	15·12	7·12
Ribs	72·66	20·57	5·12
Shoulder	76·57	18·10	3·62
Jowl	73·91	19·51	5·57
Breast	64·66	18·81	16·05
Leg	70·30	18·87	9·25

Mutton has in general a flavour which is relished by most persons, and from its tenderness is considered by many physicians to be very digestible. But the proportion of fat is often excessive, and it contains more of the glyceride of stearic acid than beef, giving the meat a characteristic and somewhat tallowy 'by-taste.' Such fat mutton is, as a rule, decidedly unsuited for invalids.

J. König gives the following as the composition of mutton:—

	Water	Albuminates	Fat
Moderately fat mutton . .	75·99	18·11	5·77
Very fat mutton . . .	47·91	14·80	36·39
From the hind quarter . .	41·97	14·39	43·47
" " breast . . .	41·39	15·45	42·07
" " shoulder . .	60·38	14·57	23·62

What has been said of the composition and properties of veal

applies, on the whole, to the flesh of the lamb, except that the latter is, as a rule, very much richer in fat.

Among the other ruminants several wild species, especially the goat and the deer, possess a certain interest as affording a meat suited to the invalid table. Their flesh has, it is true, a somewhat dense and compact structure, but this peculiarity of game is apparent to an unpleasant degree only in the case of older animals; that of younger ones, especially of young deer, is highly appreciated on account of its tenderness.

Von Bibra gives the following as the composition of venison:[1] water 74·63, albuminates 19·24 (but little gelatin being included among these), and fat 1·3 per cent. Moreover the flesh of the deer, as of most species of game, is distinguished by the large amount of sapid substances present, on which account it is usually described as 'strong and stimulating.'

The same is true of hare, which, when young, is very tender and tasty, and as regards toleration and digestibility is comparable with fowl. A mean of the analyses of J. König and B. Farwick gives for the flesh of the hare 74·16 water, 23·34 nitrogenous matters, and 1·07 fat.[2]

The flesh of the pig is indeed characterised in general by the tenderness of the fibres, but also in the fed animal by an unusually large amount of fat, greatly detracting from its digestibility. The fat of the pig, unlike that of most ruminants, consists almost entirely of palmitic and oleic glycerides.

The composition of pig's flesh is as follows:[3]—

	Water	Albuminates	Fat
Fat pork (mean) . . .	47·40	14·54	37·34
Ham	48·71	15·98	34·62
Jowl	54·63	16·58	28·03
Rib	43·44	13·37	42·59
Shoulder	40·27	12·55	46·71
Lean pork (mean) . .	72·57	19·91	6·81
Loin	73·15	17·32	8·43
Rib	73·0	17·40	8·65
Ham	69·60	20·97	8·29

The most valuable flesh for the invalid kitchen is without doubt that of the various kinds of wild and tame fowl. A young chicken has always been looked on as the lightest of all meats, and the same advantages as regards digestibility, tenderness, and flavour are pre-

[1] *Archiv für physiolog. Heilkunde*, vol. iv.

[2] J. König, l.c. and *Zeitschr. f. Biologie*, 1876.

[3] J. König, l.c.

sented by the flesh of young pigeons, partridges, and many other birds. But that of the goose is harder of digestion, from its containing, as a rule, a large amount of fat. The flesh, too, of geese, both wild and domestic, of the turkey, woodcock, &c., are in general unsuited to weak digestions.

The composition of the flesh of several kinds of fowl has been found to be as follows :—

	Water	Albuminates	Fat
Lean hen	76·22	19·72	1·42
Fat „	70·06	18·49	9·34
Young fat chicken . . .	70·03	23·32	3·15
Fat goose	38·02	15·91	45·59
Partridge	71·96	25·26	1·43
Pigeon	73·0	22·14	1·0

The flesh of several kinds of fish is generally considered an excellent food for the sick and convalescent, but this view can only be accepted with many qualifications.

The taste, the chemical composition, and the mechanical arrangement of the flesh of fishes exhibit great differences among the numerous species serving for the food of man. The quantity and the quality of the fat is especially subject to variation and this, again, is not without an influence on the taste. In the flesh of many fish there are specific odorous and sapid substances, as trimethylamine, which is found abundantly in the brine of herrings. One may certainly reckon as light and easy of digestion the flesh of the choicer fishes, which are relatively poor in fat: the poorest have a high percentage of water, and the nitrogenous matters are composed largely of gelatin.

The composition of the flesh of the several kinds of fish may be gathered from the following analyses (J. König) :—

	Water	Albuminates	Fat
Salmon	74·36	15·01	6·42
Eel	57·42	12·82	28·37
Conger eel	79·91	13·57	5·02
Herring (fresh) . . .	80·71	10·11	7·11
Pike	83·89	14·81	0·15
Perch	80·06	18·11	0·44
Sole	86·14	11·94	0·25
Carp	76·97	21·86	1·09

The flesh of some reptiles, as the turtle, and of many invertebrate animals serves as food, and some of the latter are highly esteemed as

delicacies; but most of these, as crabs, lobsters, &c., are ill adapted to feeble digestive organs. The oyster only is an easily tolerated and digestible food, but it must be in season and eaten raw, for by general consent it is, when cooked, very hard of digestion.

According to J. König and C. Krauch the collective contents of the oyster shell are composed of 89·69 parts per cent. of water, 4·95 of albuminates, 0·37 of fat, and 2·62 of extractives.

Besides the muscular substance the viscera and even the blood of several animals are used as food. But the majority of the internal organs are little adapted for use in the invalid kitchen, and this is specially the case with the lungs, liver, kidneys, and heart. The brain is considered by many as a fitting article of food for the sick and convalescent, mainly on account of its soft consistence; but one must not forget the large percentage of fat, which renders it really ill adapted to weak digestive organs. In like manner the tongue of most animals presents a very tender fibre, but is intimately permeated by a large amount of fat. It is an entirely erroneous conception that has attributed to the blood of the higher animals any special dietetic value in consideration of its composition. In its natural state the blood is by no means acceptable to the palate and is probably hard of digestion; it is, however, possible that some of its constituents, as the serum albumen, might be applied to the preparation of appropriate articles of diet.

Unlike the viscera mentioned above, the thymus gland of the calf, called calf's fry [and the pancreas] or sweetbread, are not only very palatable but easily digested, and are frequently employed in invalid cookery.

The composition of the thymus gland of the calf is given as follows: 70 per cent. water, 14 soluble and 8 insoluble albuminates, 6 gelatinous substances, and 0·4 of fat.

Flesh is only exceptionally eaten in the raw state; as a rule it is cooked in one way or another. The purpose of cooking is to render it at once more savoury and more digestible. The latter aim is attained mainly by the action of a high temperature, which coagulates the albumen and converts the connective tissues into gelatin, thus loosening the structure of the muscle, the fat at the same time being rendered fluid by the heat and partly melted out. Besides which new, savoury, and odorous

substances are developed, the action of which is as a rule heightened by various condiments.

In the dietary of the sick, milk is of scarcely less prominent importance than the muscle flesh of animals, and indeed in many cases no other food is capable of taking its place. Milk contains all the food stuffs required for the maintenance of life, and in such suitable proportions that it offers the most perfect food during the period of lactation, and under certain circumstances and for a limited time it may constitute the main article of diet even for adults.

The chief constituents of milk are water, casein, serum albumen, milk sugar, fat, extractives, and inorganic salts. These solids are all dissolved in the water, with the exception of the fat; though in the opinion of some observers the casein is not in a state of actual solution, but of extreme attenuation (*starker Quellung*).[1] The fats are suspended in the fluid in the form of the so-called milk-globules, and to these are due the white colour and opacity of milk.

It was formerly generally believed that the fat-globules were enclosed in delicate envelopes of albumen, a view founded mainly on the fact that milk gives up scarcely any of its fat when simply shaken with ether, but that the addition of caustic potash or of acetic acid renders the milk fat at once accessible to the ether. It was supposed that these reagents enabled the ether to take up the fat by dissolving the enveloping membrane. Some other phenomena, as the formation of butter, also seemed to find an easy explanation in the hypothesis of an envelope of albumen enclosing the fat-globules. Recently, however, the existence of such an envelope has been conclusively negatived by several observers, particularly by Soxhlet, and the behaviour of the milk-globules towards the above-named reagents explained on the supposition that the casein, being present in a state not of solution but of high attenuation, holds the fat in an emulsion. By the action of the said reagents this condition of emulsion is so altered that the fat can be taken up by the ether.

When fresh milk is allowed to stand at rest for some time a yellowish film forms on the surface, the so-called cream, in which the milk-globules collect in virtue of their low specific gravity. By continued agitation or stirring of the milk, the so-called churning of

[1] [Like the gelatine in thin size or the starch in well-boiled arrowroot swollen out by the absorption of water. Here *Quellung* is untranslatable.—TRANSLATOR.]

butter, the greater part of the milk fat is separated in the form of small lumps. Milk fat consists of glycerides of stearic, palmitic, myristic, oleic, butyric, and some soluble fatty acids. On long contact with the air a decomposition of the fats sets in, the rancidity of butter, during which soluble fatty acids are formed in large amount.

If milk is left to stand for a longer time, a spontaneous coagulation of the casein takes place, forming a thickish, jelly-like mass, which encloses a greenish opalescent fluid known as whey. This spontaneous curdling of milk is a consequence of the change of the milk sugar into lactic acid, caused by the action of a ferment. The formation of lactic acid in milk proceeds with greatest rapidity under the influence of the warmth of summer, while coagulation may be materially delayed by previous boiling of the milk, or by the addition of bicarbonate of soda, salicylic acid, &c.

The curdling of milk may be artificially induced by the addition of dilute acids or of rennet, but in each of the three methods the coagulation of the casein is effected in a different way. It is indeed true that the stomach of the calf contains a lactic-acid-forming ferment; but this takes little or no part in the coagulation of the casein, which is caused rather by another rennet ferment splitting the casein of the milk into two products, viz. the almost insoluble cheese curd and the easily soluble protein matter of the whey. The former of these displays in its properties considerable differences from the casein which has been obtained by acidification or spontaneous coagulation.

From a qualitative point of view the milks of the various mammals present no essential differences; their specific distinctions consist rather in odour and taste. Cow's milk is most used as food for sick and hale, but in some countries that of the goat, sheep, or mare is largely employed.

The quantitative composition of the milk of several mammals may be seen in the following table :—

	Water	Casein	Albumen	Fat	Sugar	Salts
Cow . .	87·41	3·01	0·75	3·66	4·92	0·70
Goat . .	86·91	2·87	1·19	4·09	4·45	0·96
Sheep . .	81·63	4·09	1·42	5·83	4·86	0·73
Mare . .	90·71	1·24	0·75	1·17	5·70	0·37 [1]

It must be borne in mind that these figures represent the means of numerous analyses, for the proportions of the several constituents present considerable variations under different circumstances. Thus

[1] After J. König, l.c.; compare also Gorup Besanez, *Lehrbuch der phys. Chem.*, 4th edit.

it is well known that the composition of milk varies with the duration of lactation, and that evening milking contains a much larger proportion of butter than that of the morning; the quantity and quality of the food, too, exerts considerable influence on the character of the milk. Certain kinds of fodder, as distillery grains, turnips, &c., give to the milk a characteristic flavour.

Blood occasionally appears in the milk of the cow as an abnormal constituent, imparting to it a reddish tinge. A frequent anomaly is the so-called blue milk, the blue colour depending, according to the general belief, on certain products of the decomposition of the casein produced by a low organism (*Vibrio cyanogeneüs*). Slimy or stringy milk arises from a mucous fermentation of the proteids; several drugs may also pass into the milk as anomalous constituents. A special importance attaches to the fact that the milk of diseased animals—for example, of cows the subjects of pearl disease—may contain actively infective matters. Of the other alterations that milk may undergo in quantity and quality as a consequence of pathological conditions little is known for certain at present.

In the process of skimming a large portion of the solids, especially of the fat, is removed, so that in skim milk there remain on an average 90·63 parts per cent. of water, 3·06 of nitrogenous matters, 0·79 of fat, and 4·77 of milk sugar. Cream is of very various composition, according to the quality of the milk employed and the procedure adopted for separating it. The several constituents vary between the following limits: water, 22 to 83; nitrogenous matters, 2·2 to 7·4; fat, 8·2 to 70·2; and milk sugar, 0·74 to 4·5.

With a view to giving greater stability to milk it is condensed by the removal of the water at a low temperature and the addition of cane sugar. The quantity of sugar added ranges in different factories from 20 to 75 grammes to the litre of milk. Milk condensed in this way contains on an average 26 parts per cent. of water, 12 of nitrogenous matters, 11 of fat, 16 of milk sugar, and 22 of added cane sugar.

Among the nomad peoples of Asia an alcoholic drink is prepared by the fermentation of mare's milk, called koumiss (kumys), or milk wine, which has of late been used in the treatment of disease. In default of mare's milk that of the cow may be employed. The acid ferment contained in the milk converts a part of the milk sugar into lactic acid, which in its turn transforms the rest of the milk sugar into a sugar capable of undergoing fermentation. Alcoholic fermentation is set up by the addition of a ferment of the nature of yeast. The resulting koumiss foams strongly, possesses an acidulous taste, and contains as much as 2·5 per cent. of alcohol. The albuminates of the milk are transformed into substances of the class of peptones.

The principal products obtained from milk are butter and cheese; the whey, moreover, is often used as a remedy.

Butter is the most valued of animal fats, alike on account of its agreeable flavour and its digestibility. Good butter, according to J. König, should contain water 11·7, fat 87, casein 0·5, and milk sugar 0·5. Butter, as commonly sold, contains a much higher percentage of water, which, as well as a larger proportion of the other solids of milk, favours early rancidity. The stability of butter may be greatly increased by repeated washings, by melting down, in which state it is called 'smalt,' or by the addition of salt at the rate of 20 to 25 grammes per kilo.

The milk that is left after the manufacture of butter, and known as butter milk, is a thickish fluid with a more or less sour taste and reaction, containing some fat, casein in a finely coagulated state, and the other constituents. The sugar has been in great part converted into lactic acid.

Cheese is a very important article of food, containing a large amount of nutriment. Either sweet or sour milk is used for its preparation.

When cheese is made from sour milk, the milk is gently warmed to about 50° C., in order to obtain a firmer coagulation of the casein. The whey is then pressed out, and the resulting sour-milk cheeses, or 'pot' cheeses, as they are called in Germany, are generally eaten in the fresh state. According to an analysis by Rubner,[1] a fresh pot cheese consists of water 60·27, casein 24·84, fat 7·33, ash 4·02, and milk sugar, lactic acid, &c., 3·54 parts per cent.

[English cream cheese varies within somewhat wide limits; it usually contains from 50 to 68 per cent. of fat and 2 to 3 of casein (*Wynter Blyth*).]

Sweet milk is as a rule employed in the manufacture of cheeses properly so called, and coagulated by gentle heat and the addition of rennet. The curd is then salted, pressed, and dried on the surface by exposure to the air, a higher temperature and greater pressure being used for the production of the so-called hard cheeses than for the softer kinds.

The pressed and partially dried mass next undergoes a kind of fermentation or decomposition, a process known as the 'ripening' of the cheese, and to which the flavour is mainly owing: the riper the cheese the more pronounced is its flavour. According as whole or skim milk is used in the manufacture of cheese is the product rich or poor in fat. The majority of the cheeses met with in commerce

[1] *Zeitschrift für Biologie*, vol. xv. p. 496.

belong to the class of fat cheeses, as the so-called cream cheese, which contains as much as 67 per cent. of fat, and the Roquefort [Stilton], Edamer, Cheshire, Emmenthaler, &c.

Numerous analyses of different kinds of cheese gave the following mean composition for each class :—

	Water	Nitrogenous Matters	Fat	Extractives	Ash
Rich cheese .	35·75	7·16	30·43	2·53	4·13
Middling cheese .	46·82	27·62	20·54	2·97	3·05
Poor cheese . .	48·02	32·65	8·41	6·80	4·12

The whey left after the precipitation of the casein, though of minor value as nutriment, is not unfrequently used in medical treatment.

Whey contains a small quantity of albuminates and a little fat, the larger proportion being thrown down with the casein in the curd; but it includes the greatest part of the salts as well as of the milk sugar, part of the latter being, however, changed into lactic acid.

The greater number of analyses give the mean composition of whey as follows: water 93·3, nitrogenous matters 0·82, fat 0·24, milk sugar 4·65, lactic acid 0·33, and salts 0·65.

Eggs stand high in nutritive value, and especially those of the domestic fowl, which are produced on an enormous scale for consumption; less generally used are those of the duck, goose, guinea fowl, &c. Plover's eggs are greatly esteemed as delicacies on account of their flavour.

The eggs of all birds have essentially the same chemical composition, but the relative weights of shell, yelk, and white differ, and the size of the egg varies much even among individuals of the same species.

The mean weight of a hen's egg is 50 grammes, of which 7 are shell, 27 the white, and 16 belong to the yelk.

The white of the egg consists mainly of egg albumen dissolved in water and enclosed in a fine membrane. Egg albumen presents a great resemblance in its properties to serum albumen, without being identical with it. At a temperature of about 70° C. it coagulates into a white elastic mass. It contains also a small quantity of fat (0·5 in the dried state), inorganic salts, and extractives.

In 100 parts of white of egg there was found 85·75 of water, 12·7 of albumen, 0·25 fat, and 0·5 ash.

The yelk contains a larger proportion of solids than the white, and

among these a nitrogenous body, the so-called vitellin, which according to Hoppe Seyler, splits up under the action of certain reagents into albumen and lecithin. The portion of the yelk soluble in ether contains, besides the ordinary fats, olein, palmitin, cholesterin, lecithin, and a yellow colouring matter; there are also inorganic salts, extractives, and a small quantity of grape sugar.

In 100 parts of the yelk there are 50·82 of water, 16·24 of nitrogenous matters, 31·75 of fat, and 1·09 of ash.

The yelk is thus distinguished from the white of the egg chiefly by the far greater amount of fat it contains; the salts are also unequally distributed, the chlorides being in excess in the white and the phosphates in the yelk.

The eggs of fishes are not unfrequently eaten, but are rather to be regarded as mere delicacies. They are composed in their mature state mainly of albuminates and membranous structure, but the proportion soluble in ether is considerable. The eggs of the sturgeon and its allies are, when salted, sold under the name of caviar. In some countries the roe of other fish is used as food after being dried and pressed.

J. König and C. Brimmer found the following composition of caviar: water 45·05, nitrogenous substances 31·90, fat 14·14, and salts 8·91 (including sodium chloride 6·38).

The proportion per cent. of the several constituents of the ash of the most important animal foods is shown in the following table:—

	Potassium	Sodium	Calcium	Magnesia	Oxide of Iron	Phosphoric Acid	Sulphuric Acid	Chlorine
Ash of flesh .	41·27	3·63	2·82	3·21	0·70	42·54	1·56	3·85
,, ,, milk . .	24·67	9·70	22·05	3·05	0·53	28·45	0·30	14·28
,, ,, hen's egg .	19·22	17·52	8·44	2·43	1·16	38·05	0·96	13·94

Vegetable Foods.

The foods derived from the vegetable kingdom agree with animal nutriments in containing albumen and fat, but there is a marked difference between the products of the two kingdoms from several points of view.

In vegetable foods the non-nitrogenous constituents are generally in overwhelming excess of the nitrogenous, and are present chiefly in the form of carbohydrates, while if we except certain seeds and fruits, the fats enter but slightly into their composition.

The difference between the relative proportions that the nitrogenous and non-nitrogenous aliments bear to one another in animal and vegetable foods is shown in the following table :—

	Nitrogenous Constituents	Fat	Carbohydrates	Salts
Fat beef	51·4	45·6	—	3·0
Lean "	89·4	5·5	—	5·1
Pea flour	27·3	0·8	68·9	3·0
Wheat flour	16·6	0·9	81·9	0·6
Rice	7·7	0·4	91·2	0·7[1]

A further difference between animal and vegetable foods is found in the fact that the latter are far less completely digested and utilised by the human organs than the former, owing chiefly to the distribution and mechanical arrangement of the nutritious constituents.

In vegetable as in animal foods we meet with several modifications of the albuminates—(1) vegetable albumen, which when separated from vegetable juices by coagulation with heat, exhibits in its properties as well as in the percentage of its composition a close agreement with egg albumen ; (2) vegetable casein, or legumin, chiefly found in the seeds of the leguminosæ, which has all the essential characters of the casein of milk, being, like it, precipitated from its solution by acetic acid and rennet, but not by heat; (3) gluten, which is contained in the cereals, and especially in wheaten flour, and when treated with alcohol breaks up into vegetable fibrin and gliadin.

It is not uninteresting to compare the percentage composition of these three vegetable albuminates with that of the three corresponding animal substances :—

	C	H	N	O	S
Flesh albumen	52·89	7·17	16·18	22·18	1·58
Egg "	53·40	7·0	15·70	22·40	1·60
Vegetable albumen	53·06	7·33	16·58	21·93	1·10
Milk casein	53·55	7·10	15·83	25·52	
Legumin	51·48	7·02	18·22	22·88	0·40
Syntonin	53·97	7·21	15·57	22·03	1·21
Vegetable fibrin	54·49	7·35	16·91	20·41	0·84
Gliadin	52·53	7·07	18·20	20·95	1·25
Animal gelatin	49·85	6·65	18·20	25·30	

[1] F. Hofmann, *Die Bedeutung von Fleischnahrung und Fleischconserven.* Leipzig, Vogel, 1880.

We thus see that the animal albuminates are on the whole richer in nitrogen, and some of them in carbon, than the corresponding vegetable products, which in the opinion of some indicates a higher nutritive value: calculated thus gluten, or vegetable fibrin, would take the highest place of all.

There are also in vegetable food certain other nitrogenous bodies, as asparagin, not belonging to the albuminates, which pass out of the system as urea; but these combinations have no nutritive value.

The vegetable fats are, at the ordinary temperature, some solid and some liquid, and generally contain a large proportion of free fatty acids. In most vegetable foods there is, however, as we have said, but very little fat. Consequently the liquid fats, called oils, obtained from several fruits and seeds are often used as an addition to other foods.

A distinction is drawn between non-drying and drying oils, the latter hardening gradually on exposure to the air into a resinous mass, while the former become sooner and more easily rancid. The non-drying oils are preferred for food, and olive oil is the most prized. Of the drying oils that of the poppy has the best taste and is not unfrequently used instead of olive oil.

The carbohydrates, which are present in large amount in all vegetable foods, constitute a numerous group of compounds in which oxygen and hydrogen exist in the same proportions as they do in water. To this circumstance they owe their name.

The carbohydrate of most importance as nutriment is starch, which occurs in large quantities in all plants and especially in the seeds of the cereals, and legumens, and in certain tubers, as the potato. The form and size of the starch granules in different plants exhibit well-marked characters, which probably have some bearing on their digestibility.

Starch is insoluble in cold water, but in hot water it swells out and constitutes what is called paste. The temperature at which the formation of a paste takes place differs in the several kinds of starch. By the action of certain reagents starch is converted into dextrin and ultimately into grape sugar; a like result is effected by several ferments, as diastase, saliva, and the secretions of the pancreas and enteric glands.

Inulin and lichenin possess similar properties (the latter is an essential constituent of Iceland moss and other species of lichen), so do the various kinds of gum and mucin.

Cellulose, which is very closely allied to starch and abundant in all plants, is capable of digestion by the human organs only when still in a young and tender condition. The further the process of

lignification has proceeded, the less digestible is the cellulose, and it presents an impediment to the utilisation of the other nutritive substances contained in the particular food.

Of the other carbohydrates present in plants the most important are the different kinds of sugar, since, as we have already remarked, they are not only nutritious in themselves, but constitute a valuable accessory and relish to other foods.

Grape sugar is present as such in the juice of grapes and of other sweet fruits, and may also be obtained artificially from other carbohydrates, especially starch. The action of yeast on grape sugar is to break it up into alcohol, carbonic acid, and some by-products (alcoholic drinks). Other ferments, particularly those of putrescent nitrogenous matters, convert the grape sugar into lactic and butyric acids.

Cane sugar has a sweeter taste than grape sugar, and is on that account much preferred for sweetening foods. It is largely contained in the juices of the sugar cane, certain species of maple, beetroot, and of the flower buds of the cocoa palm. Cane sugar does not appear to be directly fermentable, but is previously changed by the action of yeast into grape sugar.

The remaining varieties of sugar, as fruit sugar and melitose, as well as the unfermentable inosit and mannit, are of little interest as foods, for it is very seldom that they are intentionally used in place of sugar. The same may be said of pectin, which is largely contained in the pulp of fleshy fruits and in conjunction with water forms the so-called fruit jelly, and of the glucosides and vegetable acids.

The Cerealia.

The seeds of the various species of corn have from the earliest ages formed one of the most important articles of consumption by the human race, and indeed they appear from their composition to be the best adapted for the purpose among the products of the vegetable kingdom. The seeds of the cereals generally are rich in starch and cellulose, with small quantities of gum, sugar, and fat. The proportion of nitrogenous constituents varies in the different species between 5 and 14 per cent.

The various kinds of corn require for their successful cultivation special conditions of soil and climate, so that in most countries only a single species can as a rule be grown with advantage. The character of the soil and climate and the

manure applied exert a certain influence on the chemical composition of the grain.

As a rule the seeds of cereals are used in the form of meal. The chief aim of grinding is, besides the mere reduction of the grain to powder, the separation of the indigestible cellulose that surrounds each proper seed. Since, however, the yellow gluten layer lies immediately beneath the external woody coat, it is impossible by any process of grinding and sifting to entirely remove the outer layers of cellulose without withdrawing at the same time a considerable part of the gluten in the bran. Consequently the finer kinds of flour contain a less amount of nitrogenous substances and a larger proportion of starch than the coarser and more glutinous meals.

The most important kinds of corn in temperate climates are wheat and rye, and for warmer lands maize and rice : of subordinate and more limited use are barley, oats, millet, sorghum or durrha, and buckwheat.

Wheat yields a finer flour than any other corn; it is especially used for making white bread, and is otherwise extensively employed. Other products, as groats and the like as well as starch, are also manufactured from wheat. In the last-named manufacture large quantities of gluten are obtained as a by-product.

Rye meal is never so fine or white as wheaten flour, and is chiefly employed for the various kinds of black bread.

Rice is the grain almost exclusively cultivated in most tropical countries, and it is imported into Europe in considerable quantities. The grains when separated from the husk are still enveloped in the so called silver skin, which is removed before the rice is used for purposes of food. Rice flour and rice starch are also found in the market.

Maize is in like manner chiefly cultivated in warmer climates, where it is largely ground into flour. Polenta, the popular dish of Italy, is thus made from the meal of maize. In our country maize is mostly used for farm purposes or for the manufacture of starch, and the fine meal known in the market as maizena or corn flour consists almost entirely of starch.

Barley and oats are employed to a much less extent as meal, and it is only in barren districts or in times of dearth that they are used for making bread at least without an admixture of the finer kinds of flour. These grains are commonly employed in the form of groats or pearl barley, and the same is true of buckwheat and millet.

The mean composition of the various kinds of corn is as follows :—

	Water	Nitrogenous Substances	Fat	Starch, Sugar, Gum, &c.	Cellulose	Ash
Wheat . . .	13·56	12·42	1·70	67·89	2·66	1·79
Spelt . . .	14·30	12·26	70·48		1·16	1·80
Rye . . .	15·26	11·43	1·71	67·83	2·01	1·77
Barley . . .	13 78	11·16	2·12	65·51	4·80	2·63
Oats . . .	12·92	11·73	6·04	55·43	10·83	3·05
Millet, shelled .	11·26	11·29	3·56	67·33	4·25	2·31
Buckwheat . .	11·36	10·58	2·79	55·84	16·52	2·91
Sorghum . .	13·12	9·15	3·45	71·81		2·47
Maize . . .	13·88	10·05	4·76	66·78	2·84	1·69
Rice grain . .	13·23	7·81	0·69	76·40	0·78	1·09
Prepared rice .	14·41	6 94	0·51	77·61	0·08	0·45

The next table shows the composition of the different kinds of flour.

	Water	Nitrogenous Substances	Fat	Starch, Sugar, Gum, &c.	Cellulose	Ash
Fine wheaten flour	14·86	8·91	1·11	74·28	0·33	0·51
Coarse ,, ,,	12·18	11·27	1·22	73·65	0·84	0·84
Wheaten groats .	12·52	10·43	0·38	75·95	0·22	0·50
Fine rye meal .	13·99	10·21	1·64	73·54	0·64	0·98
Coarse ,, ,, .	14·77	11·06	2·09	67·78	2·61	1·69
Fine barley groats	14·83	10·89	1·23	71·85	0·47	0 63
Pearl barley . .	12·82	7·25	1·15	76·19	1·36	1·23
Oat meal . .	10·07	14·29	5·65	65·73	2·24	2·02
Buckwheat meal .	14·27	9·28	1·89	72·46	0·89	1·21
Maize meal . .	10·60	14·0	3·80	70·68		0·86
Rice flour . .	14·15	7·43	0·89	77·62		

The following figures give the mean composition of the ash of the various kinds of grain and meal :—

	Potash	Soda	Lime	Magnesia	Iron Oxide	Phosphoric Acid	Sulphuric Acid	Silicic Acid	Chlorine
Winter wheat .	31·16	2·25	3·34	11·97	1·31	46·98	0·37	2·11	0·22
Summer wheat	29·99	1·93	2·93	12·09	0·51	48·63	1·52	1·64	0·48
Finest wheat-meal . .	34·42	0·76	7·48	7·70	0·61	49 38	—	—	—
Coarse ditto .	30·98	0·98	6·32	11·22	0·44	50·18	—	—	—
Spelt, shelled .	35·63	3·59	3·09	12·01	1·81	42·07	—	1·0	—
Rye . . .	31·47	1·70	2·63	11·54	1·63	46·93	1·10	1·88	0·61
,, flour . .	38·44	1·75	1·02	7·99	2·54	48·26	—	—	—
Barley . .	20·15	2·53	2·60	8·62	0·97	34·68	1·69	27·54	0·93
,, meal .	28·77	2·54	2·80	13·50	2·0	47·29	3·10	—	—
Oats . . .	16·38	2·24	3·73	7·06	0·67	23·02	1·36	44·33	0·58
Millet, shelled .	18·53	3·82	—	21·44	1·82	48·21	2·02	8·33	—
Buckwheat .	23·07	6 21	4·42	12·42	1·74	48·67	2·11	0·23	1·30
Rice, dressed .	21·73	5·50	3·24	11·20	1·23	53·68	0·62	2·74	0·10

The Leguminosæ.

The pods of these plants in their young and unripe state are watery, and on this account are usually classed with culinary vegetables; but the ripe seeds are characterised by containing a large amount of nitrogenous substances, surpassing in this respect all other vegetable foods. In contrast with the cereals, which yield gluten, the proteids of the legumens exist in the form of vegetable casein.

That they also contain a large proportion of non-nitrogenous matters, chiefly in the form of starch, gives them a high value as articles of food; indeed, they would probably compete with the cereals if they were as well adapted for making bread and were otherwise as palatable as the latter. This, however, is not the case, and the legumens are as a rule boiled in their natural state as vegetables, and in this form at least they are but imperfectly digested and utilised even by healthy organs. In some circumstances, however, the meal of legumens may be of the highest value in the treatment of enfeebled digestion.

To the group of legumens belong the pea, beans, and lentils.

Under the names of ervalenta, revalenta arabica, and revalescière a farinaceous food has long been sold combining with a high nutritive value some curative power. In reality it is a mixture of lentil with pea, bean, and maize meal, to which oat and barley meal, &c., are sometimes added. Revalenta has the advantage of presenting a leguminous meal of the finest quality.

W. Beneke has within the last few years strongly recommended the use of fine leguminous meals in the feeding of the sick.[1] In his opinion the best form is that of fine lentil flour, but, since the amount of the nitrogenous constituents is too great compared with the non-nitrogenous, the due proportion should be obtained by the addition of rye flour, as each case may require.

Against this proposal several objections may be urged, above all the question whether even the finest quality of leguminous meal can in all circumstances, be well digested and tolerated; that it cannot provide a true substitute for flesh seems to me *à priori* indisputable.

[1] W. Beneke, 'Ueber einen Ersatz der Fleischnahrung bei Reconvalescenten, verschiedenen Krankheitszuständen des Magens und Darmkanals und bei unbemittelten Kranken,' *Berlin. klin. Wochenschrift*, 1872, No. 15.

The following table shows the mean composition of the seeds of the leguminosæ:—

	Water	Nitrogenous Substances	Fat	Starch, &c.	Cellulose	Ash
Field beans . .	14·84	23·66	·63	49·25	7·47	3·15
Garden „ . .	13·60	23·12	2·28	53·63	3·84	3·53
Peas . . .	14·31	22·63	1·72	53·24	5·45	2·65
Lentils . .	12·51	24·81	1·85	54·78	3·58	2·47

The ashes of the legumens have the following composition:—

	Potash	Soda	Lime	Magnesia	Oxide of Iron	Phosphoric Acid	Sulphuric Acid	Silica	Chlorine
Field beans .	42·49	1·34	4·73	7·08	0·57	38·74	2·53	0·73	1·57
Garden „ .	44·01	1·49	6·38	7·62	0·32	35·52	4·05	0·57	0·86
Peas . .	41·79	0·96	4·99	7·96	0·86	36·43	3·49	0·86	1·54
Lentils . .	34·76	13·50	6·34	2·47	2·0	36·30	—	—	4·63

Roots.

In nutritive value these stand far below the cereals and legumens, in consequence of the large amount of water and small proportion of albuminates they contain. Several of the tubers used as food are remarkable for the quantity of starch in their composition. Some culinary roots contain, besides starch, much cane and fruit sugar and pectin; and a few also vegetable acids. A certain importance attaches also to the circumstance that most roots are rich in ash, especially in the potash salts.

Of all roots the potato is the most extensively employed as an article of food, chiefly perhaps from the fact that with it a greater weight of produce can be obtained from a given space of ground. But the proportions in which the several alimentary principles exist in the potato is alone sufficient to prove that it can by itself constitute but a most inadequate diet, and when it is so used it exerts a most injurious influence on the nutrition of the population.

The mean composition of the potato is, according to J. König—

Water	Nitrogenous Matters	Fat	Starch	Cellulose	Ash
75·77	1·79	0·16	20·56	0·75	0·97

It may here be mentioned that a part of the nitrogenous constituents are in the form of asparagin and amidic acid.

The juice of the potato has an acid reaction, from the presence of vegetable acids.

The mean composition of the ash of the potato is as follows:—

Potash	Soda	Lime	Magnesia	Oxide of Iron	Phosphoric Acid	Sulphuric Acid	Silica	Chlorine
60·37	2·62	2·57	4·69	1·18	17·33	6·49	2·13	3·11

The value of the potato as food consists almost entirely in the large proportion of starch, which varies between 12 and 24 per cent. The cellular tissue surrounding the starch granules is, with the exception of the outer rind, tender and easily digested.

The potato is largely employed for the manufacture of starch, and a great part of the raw starch of commerce is obtained from this source.

The quality of the potato, and especially its flavour, depends greatly on the character of the soil and on the season; the finest are those grown in a sandy and permeable soil. After long keeping a part of the starch is converted into sugar, gum, &c., and a similar change occurs from the action of frost, when the tissues undergo changes leading to speedy putrefaction.

Several other roots have been suggested for cultivation in Europe as substitutes for the potato, such as those of the *Ullico tuberosus*, *Apios tuberosum*, and especially the *Dioscorea Batatas*, but hitherto without success. Many tropical and subtropical plants have roots extremely rich in starch, and very fine kinds of starch flour, known in commerce as arrowroot, are obtained from the *Maranta arundinacea*, indigenous to the West Indies, as well as from the rhizomes of the *Curcuma angustifolia* in the East Indies and others. The root of the *Manihot utilissima* yields cassava starch and tapioca, the latter being prepared, after the manner of sago, by drying the starch on hot plates.

Besides the above-named roots the stems of several palms yield a starch employed for the production of sago. For this purpose the clarified starch is heated in metal pans, whereby a part is converted into paste.

The numerous other roots eaten by mankind can even less than the potato be regarded as complete nutriments; they can only rank as vegetables, i.e. as fitting adjuncts to other articles of food. Such are the various kinds of carrot, beetroot, turnip, celery [the German tuberous variety], kohl rabi, radish, horse radish, and lastly the alliaceous tribe, of which the onion is most used. The leaves and

stems of leeks and garlic are also employed as an addition to other dishes. Several of these roots have a more or less sweet taste; others, again, as the radish, horse radish, and the onion tribe, are marked by the presence of acrid substances, the oils of mustard and of garlic. The leaves and stalks of several of these, as celery, parsley, and the leek tribe, are often added to dishes on account of their flavour.

As an indication of the composition of the various garden roots we give the means of the analyses collected by König in the following table :—

	Water	Nitrogenous Substances	Fat	Cane and Fruit Sugar	Non-nitrogenous Extract other than Sugar	Cellulose	Ash
Field carrots .	87·05	1·04	0·21	6·74	2·60	1·40	0·90
Garden „ . .	88·32	1·04	0·21	1·60	7·17	0·95	0·71
Turnips . .	91·24	0·96	0·16	4·08	1·90	0·91	0·75
Teltower carrots .	81·90	3·52	0·14	1·24	10·10	1·82	1·28
Beetroot . .	87·07	1·37	0·03	0·54	9·02	1·05	0·92
Kohl rabi . .	85·01	2·95	0·22	0·40	8·45	1·76	1·21
Scorzonera . .	80·39	1·04	0·50	2·19	12·61	2·27	0·99
Celery . . .	84·09	1·48	0·39	0·77	11·03	1·40	0·84
Horse radish .	70·72	2·73	0·35	—	15·89	2·78	1·53
Radish . . .	86·92	1·92	0·11	1·53	6·90	1·55	1·07
Small radish .	93·34	1·23	0·15	0·88	2·91	0·75	0·74
Onions . . .	85·99	1·68	0·10	2·78	8·04	0·71	0·70

The mineral constituents have not as yet been determined for all the above-named roots; the available analyses are the following :—

	Potash	Soda	Lime	Magnesia	Oxide of Iron	Phosphoric Acid	Sulphuric Acid	Silica	Chlorine
Carrot . .	35·21	22·07	11·42	4·73	1·03	12·46	6·72	2·47	5·19
Turnip .	45·40	9·84	10·60	3·69	0·81	12·71	11·19	1·87	5·07
Kohl rabi .	35·31	6·53	10·97	6·84	3·02	21·90	8·84	2·48	4·94
Celery . .	43·19	—	13·11	5·82	1·41	12·83	5·58	3·85	15·87
Horse radish	30·76	3·96	8·23	2·91	1·94	7·75	30·79	12·72	0·94
Radish .	21·98	3·75	8·78	3·53	1·16	41·12	7·71	8·17	4·90
Onion . .	25·05	3·18	21·97	5·29	4·53	15·03	5·46	16·72	2·77

Green Vegetables.

These without exception contain a large amount of water with but a very small proportion of nutritive matter; and, further, they present a greater resistance to the action of the digestive

juices the older and more lignified their tissues. Among the non-nitrogenous constituents we find, besides cellulose, chlorophyll and small quantities of fat, sugar, gum, pectin, and vegetable acids. Their specific tastes and odours are due to the presence of essential oils and other sapid matters. They can clearly play but a very subordinate part in the repair of the tissues, but as adjuncts to other foods they constitute an important part of our diet, acting in part at least as relishes. A certain value also attaches to the inorganic salts which enter largely into their composition.

Foremost among green vegetables stand the various kinds of cabbage, as the white cabbage, cauliflower, winter or curly greens, the blue or red cabbage, savoy, &c. After these come spinach, the lettuce, endive, and other salad herbs.

The young sprouts of the asparagus are a much-esteemed dish; the receptacles of the artichoke,[1] and in some districts the young shoots of hops, are eaten with zest.

The pods and seeds together of the sugar pea and French bean or scarlet-runner may be classed with green vegetables, though they are somewhat richer in nitrogenous matter than are those of which the leaves alone are used.

From available analyses König calculates the following mean composition of several green vegetables :—

	Water	Nitrogenous Substances	Fat	Sugar	Other Non-nitrogenous Substances	Cellulose	Ash
White cabbage .	89·97	1·89	0·20	2·29	2·58	1·84	1·23
Red " .	90·06	1·83	0·19	1·74	4·12	1·29	0·77
Cauliflower .	90·39	2·53	0·38	1·27	3·74	0·87	0·82
Winter greens .	80·03	3·99	0·90	1·21	10·42	1·88	1·57
Butter kohl .	86·96	3·01	0·54	1·47	5·72	1·20	1·10
Brussels sprouts	85·63	4·83	0·46	—	6·22	1·57	1·29
Spinach . .	90·26	3·15	0·54	0·08	3·26	0·77	1·94
Endive . .	94·13	1·76	0·13	0·76	1·82	0·62	0·78
Lettuce . .	94·33	1·41	0·31	—	2·19	0·73	1·03
Corn salad .	93·41	2·09	0·41	—	2·73	0·57	0·79
Asparagus[2] .	93·32	1·98	0·28	0·40	2·34	1·14	0·54
French beans .	88·36	2·77	0·14	1·20	6·82	1·14	0·57
Garden peas . (unripe seeds)	80·49	5·75	0·50	—	10·86	1·60	0·80

[1] Moleschott gives, on the authority of Richardson, for the common artichoke: water 81·08, organic matter 17·75, and mineral constituents 1·17 per cent.

[2] About 14·5 per cent. of the nitrogenous constituents of asparagus are in the form of asparagin.

The percentage composition of the ash of several vegetables is given below :—

	Potash	Soda	Lime	Magnesia	Oxide of Iron	Phosphoric Acid	Sulphuric Acid	Silica	Chlorine
Asparagus .	31·03	11·59	10·48	4·90	2·99	20·12	6·36	6·60	—
White cabbage	37·82	14·42	9·36	3·52	0·15	12·30	15·46	—	6·97
Spinach . .	16·56	35·29	11·87	6·38	3·35	10·25	6·87	4·52	6·29
Lettuce . .	37·63	7·54	14·68	6·19	5·31	9·19	3·76	8·14	7·65

Fruits.

However the numerous kinds of fleshy and juicy fruits may differ among themselves in taste and other properties, they present a great sameness regarded as articles of food. They are all rich in water; the solid constituents comprise but little albumen, consisting mainly of sugar, vegetable acids partly combined with bases, pectin and cellulose. We also find in most small quantities of fat and of waxy and colouring matters. The aroma of fruits is for the most part due to the presence of essential oils and of compound ethers.

From the small amount of nutriment they contain the greater number of fruits can scarely be considered to possess any value as foods, but they are among the best of luxuries in virtue of their flavour, which not only agreeably excites the organs of taste but is capable of exerting a beneficial influence on those of digestion. The large amount of salts, especially those of the alkalies with the vegetable acids, must not be overlooked; the last are converted in the system into carbonates, and the urine, after a liberal consumption of fruits, takes on an alkaline reaction.[1]

Fruits are distinguished by their form into stone fruits, pomes, berries, capsules, pepos, and nuts.

[1] It is possible that in tropical countries certain fruits, as the breadfruit, the baobab, bananas, and dates, may play a more important part in the dietary of the inhabitants than could be the case in our climate; but our knowledge of the habits and mode of life of those peoples is too defective to justify us in drawing general conclusions from the predominant use among them of fruits as articles of diet.

The following table gives the composition of all the more important fruits :—

	Water	Nitrogenous Matters	Free Acids	Sugar	Other Non-nitrogenous Matters	Cellulose and Kernel	Ash
Apple	83·58	0·39	0·84	7·73	5·17	1·98	0·31
Pear	83·03	0·36	0·20	8·26	3·54	4·30	0·31
Quince	81·18	0·78	0·85	6·15	4·92	5·41	0·71
Plum	84·86	0·40	1·50	3·56	4·68	4·34	0·66
Greengage	80·28	0·41	0·91	3·16	11·46	3·39	0·39
Peach	80·03	0·65	0·92	4·48	7·17	6·06	0·69
Apricot	81·22	0·49	1·16	4·69	6·35	5·27	0·82
Grape	78·18	0·59	0·79	24·36	1·96	3·60	0·53
Cherry	80·26	0·62	0·91	10·24	1·17	6·07	0·73
Strawberry	87·66	1·07	0·93	6·28	0·48	2·32	0·81
Raspberry	86·21	0·53	1·38	3·95	1·54	5·90	0·49
Bilberry	78·36	0·78	1·66	5·02	0·87	12·29	1·02
Gooseberry	85·74	0·47	1·42	7·03	1·40	3·52	0·42
Currants	84·77	0·51	2·15	6·38	0·90	4·57	0·72
Oranges (without rind or pips)	89·01	0·73	2·44	4·59	0·95	1·79	0·49
Cucumber	95·60	1·02	—	0·95	1·33	0·62	0·39
Melon	95·21	1·06	—	0·27	1·16	1·07	0·63

The dried fruits most commonly used have the following composition :—

	Water	Nitrogenous Matters	Fat	Free Acid	Sugar	Other Non-nitrogenous Matters	Cellulose and Seeds	Ash
Apple	27·95	1·28	0·82	3·60	42·83	17·0	4·95	1·57
Pear	29·41	2·07	0·35	0·84	29·13	29·67	6·86	1·67
Quince	29·30	2·35	0·53	2·72	44·35	17·89	1·48[1]	1·38
Cherry	49·88	2·07	0·30	—	31·22	14·29	0·61[1]	1·63
Raisin	32·02	2·42	0·59	—	54·26	7·48	1·72	1·21
Fig	31·20	4·01	1·44	1·21	49·79	4·51	4·98	2·86

The composition of the ash of a few of the above-named fruits is as under :—

	Potash	Soda	Lime	Magnesia	Oxide of Iron	Phosphoric Acid	Sulphuric Acid	Silica	Chlorine
Apple	35·68	26·09	4·08	8·75	1·40	13·59	6·09	4·32	—
Pear	54·69	8·52	7·98	5·22	1·04	15·20	5·69	1·49	—
Plum (flesh)	48·54	9·05	11·47	3·58	2·54	16·01	3·23	3·15	0·38
Strawberry	21·07	28·48	14·21	—	5·89	13·82	3·15	12·05	1·69
Gooseberry	38·65	9·92	12·20	5·85	4·56	19·68	5·89	2·58	0·75
Cucumber	51·71	4·19	6·97	4·50	0·75	13·10	5·70	4·25	9·16

[1] After removing the seeds.

Besides these fleshy and juicy fruits we have to notice almonds, nuts, and chestnuts. The two former are remarkable for the large amount of fat, the last of sugar and starch. Sweet almonds contain 3 to 5 per cent. of sugar, but no starch. In the bitter almond we find a fermentable body, amygdalin, which, when the kernel is crushed and moistened, is converted by the action of emulsin, a ferment present in all almonds, into oil of bitter almonds, hydrocyanic acid, and sugar. Sweet almonds do not contain any amygdalin. König gives the composition of these as follows:—

	Water	Nitrogenous Matters	Fat	Carbo-hydrate	Cellulose	Ash
Sweet almond .	5·39	24·18	53·68	7·23	6·56	2·96
Walnut . .	4·68	16·37	62·86	7·89	6·17	2·03
Hazel nut . .	3·77	15·62	66·47	9·03	3·28	1·83
Chestnut . .	51·48	5·48	1·37	38·34	1·61	1·72

Fungi and Lichens.

Edible fungi are remarkably rich in nutritive, especially nitrogenous, matters and in ash, and among the non-nitrogenous constituents we find mannite and grape sugar. Judging from their chemical composition, they ought to have no small value as foods, but it is doubtful how far they are really utilised in the human alimentary canal. Many fungi, as the mushroom and truffle, owe their repute not to their nutritive value, but to their agreeable flavour, resembling the very finest sausage.

The composition of the most used fungi is thus given by König:—

	Water	Nitrogenous Substances	Fat	Grape Sugar, Mannite	Other Non-nitrogenous Substances	Woody Fibre	Ash
A. In the fresh state :							
Mushroom . .	91·11	2·57	0·13	1·05	3·71	0·67	0·76
Other agarics .	86·41	3·18	0·40	1·44	6·04	1·02	1·51
Truffle . .	72·8	8·91	0·62	—	7·54	7·92	2·21
Steinmorchel .	90·0	3·0	0·19	0·74	3·87	0·67	0·93
Common morell .	90·0	3·48	0·24	0·72	3·95	0·67	0·94
Boletus edulis .	90·79	3·83	0·15	1·0	3·63	0·87	0·97
B. Air-dried :							
Mushroom . .	17·54	23·84	1·21	9·59	34·56	6·21	7·05
Truffle . .	17·0	27·18	1·89	—	23·05	24·16	6·72
Common morell .	19·04	28·48	1·93	5·80	31·62	5·50	7·63
Boletus edulis .	12·81	36·12	1·72	4·47	32·79	5·71	6·38

The ash of the fungi is given as follows by J. König:—

	Potash	Soda	Lime	Magnesia	Oxide of Iron	Phosphoric Acid	Sulphuric Acid	Silica	Chlorine
Mushroom .	50·71	1·69	0·75	0·53	1·16	15·43	24·29	1·42	4·58
Truffle . .	54·21	1·61	4·95	2·34	0·51	32·96	1·17	1·14	—
Morel . .	49·51	0·34	1·59	1·90	1·86	39·03	2·89	0·87	0·89
Boleti . .	55·58	2·53	3·47	2·31	1·06	23·29	10·69	—	2·02

The so-called Iceland moss, belonging to the family of lichens, is much used by the inhabitants of the northern Arctic zone. After the removal of a bitter extractive, by means of repeated washing, a bread of a pleasant taste is made from the moss. This lichen bread has a certain interest from the fact that it has been recommended as a substitute for the ordinary diabetic bread.[1]

Iceland moss contains two bitter-tasting acids, cetraric and lichenstearic. The proportion of the several constituents is, according to König, water 15·96, nitrogenous matter 2·19, fat 1·41, non-nitrogenous matter 76·12 (including lichenin 55·65), woody fibre 2·91, and ash 1·41.

Relishes and Articles of Luxury.

Saccharine matters must be regarded as relishes although, as has been already pointed out, they partake also of the nature of foods. Some idea, however, may be formed of the value of sugar as a luxury by comparing the sums paid for it when an equivalent amount of nourishment in other forms could be had for so much less. It is on account of its sweet taste that sugar is in so great request as an addition to articles of food and drink of the most diverse kinds.

For sweetening food or drink cane sugar is preferred; it is obtained from the sugar cane and beetroot, and in smaller quantities from the sugar maple, date palm, and sugar pea. The raw sugar extracted from these plants contains several by-products and no inconsiderable proportion of mineral matters; by the process of refining the purer kinds of sugar are prepared, consisting almost entirely of cane sugar, with not more than $\frac{1}{4}$ or $\frac{1}{2}$ per cent. of impurities and ash.

[1] See Senator, 'Diabetes mellitus,' in Ziemssen's *Handb. der spec. Pathologie*, p. 534, vol. xiii. 2nd edit.

The inferior kinds contain 96 to 99 per cent. of sugar, 0·2 to 2·3 per cent. of water, and 1 to 2·3 per cent. of organic and inorganic impurities. The residues remaining after the crystallisation and refining are known in commerce as treacle or molasses, and contain, besides uncrystallisable sugar, several organic and inorganic admixtures. Molasses give an acid reaction and develope by heating acetic and formic acids (J. König).

Sugar candy is distinguished from loaf sugar only by its being caused to assume the crystalline form very slowly.

Grape sugar is very inferior to cane sugar in its sweetening power, and is chiefly employed for technical purposes. It is for the most part prepared from starch, and is met with in commerce either in the crystalline form or as syrup. The crystalline commercial starch sugar contains on an average 17·05 per cent. of water, 64·39 of grape sugar, and 18·56 of unfermentable substances. In the syrup the proportion of grape sugar is less and of unfermentable matters greater.[1]

The honey of bees took the place of sugar in ancient days, when the latter was as yet unknown.

The quality of honey, and especially its odour and flavour, depends very much on the plants from which it is collected. On an average honey consists of 16·13 per cent. of water, 1·29 of nitrogenous matter, 78·74 of fruit, and 2·69 of cane sugar, with 0·12 of ash.[1]

Alcohol.

In a still higher degree than the saccharine bodies do alcoholic drinks owe their value to the influences which they bring to bear on the nervous system in various directions, while with regard to metabolism they seem to play only a subordinate part. The correctness of this view is generally accepted, although many competent authorities, as Binz and others, believe that the undeniably favourable action of alcohol in grave morbid processes is in part at least of a material character, the alcohol being consumed in the evolution of heat and vital force, and saving from destruction the actual constituents of the body.[2] It is indeed possible that the tissue-

[1] Besides molasses and the syrup of starch sugar, the expressed and boiled juice of sugar beet, fruit, &c., is often sold as syrup and used in place of sugar (J. König).

[2] For the literature of the subject see the *Handb. d. Arzneimittellehre* of H. Nothnagel and M. J. Rossbach, Berlin, 1878, and the article by R. Boehm in Ziemssen's *Handb. der spec. Pathol.*, vol. xv.

saving power of alcohol seen in pathological states is more conspicuously manifested during abnormal acceleration of the metabolic processes than under normal conditions. I am, however, of opinion that the favourable effects of the administration of alcoholic drinks in many diseases are satisfactorily explained if we regard them solely as excitants and stimulants, those especially which contain no appreciable constituents other than alcohol and water, and estimate their nutritive properties as insignificant.

It has been known from the earliest ages that saccharine fluids under certain conditions undergo alcoholic fermentation, whereby agreeably exciting or intoxicating drinks are produced.

This fermentation is set up by the yeast fungus, which breaks up the sugar into ethyl alcohol and carbonic acid, a small proportion being at the same time converted into other products, as glycerin, succinic acid, &c. The juices of sugar-yielding plants are generally used for the preparation of alcoholic drinks, or the starch of various roots and seeds is previously transformed into sugar, a change mostly brought about by the action of diastase. The chief representatives of alcoholic drinks are wine, beer, and spirits.

Wines vary greatly as regards their characteristic properties with the soil, season, mode of manufacture, and their age.

In the manufacture of white wines the grape juice, after having been left for several days in contact with the crushed skins, in order that the soluble constituents of these may be extracted, is pressed out, and the must so obtained is submitted to fermentation, which sets up of itself on mere exposure to the air by means of the yeast germs everywhere present. To make a red wine the juice of black grapes is fermented together with the skins and stones, and the colouring matters as well as the tannin contained in these are dissolved out into the wine.

The following mean composition of grape must is obtained from a large number of analyses :—

In 100 parts	Water	Nitrogenous Substances	Sugar	Acid	Other Non-nitrogenous Substances	Ash
	74·49	0·28	19·71	0·64	4·48	0·40

The proportions of the grape sugar and of acids in the must vary between wide limits with the aspect and soil, but even in the same

place in the course of several seasons fluctuations are observed in the sugar of 12 to 24 per cent. and in the acid of 0·5 to 1·2. As a rule the amount of acid is inversely as that of the sugar.[1]

During the several phases of the fermentation, and the processes to which the new wine is submitted with a view to clarifying, it is obvious that its composition will be essentially changed from that of the original must. In the matured wine the greater part of the sugar present in the must is converted into alcohol, with the simultaneous formation of glycerin and succinic acid; there is nevertheless in most wines a certain residue of sugar, which may amount to several parts per cent. The tartaric acid and the tartrates of the must pass over but partially into the wine; malic, acetic, and other organic acids are generated; tannin is present in any large amount only in red wines. Besides these, wines contain no inconsiderable quantity of extractives, traces of albuminous substances, and several ethers, which give to the wine what is known as its bouquet. The ash is composed of two-thirds of potash, and contains also a large amount of phosphoric acid. On long keeping the sugar and extractives gradually diminish in amount, while for a time at least the percentage of alcohol probably increases.

As regards the composition of wines from the several districts, only approximate estimates can be made from analyses, however numerous, since the proportion of the more important constituents exhibits great variation in different seasons. For the comparison of the different kinds of wine with one another it would be necessary that all analyses should be made on the growths of the same year, and be conducted according to a uniform method. Moreover, mere chemical analysis is not enough to determine the quality of a wine, and just as little can it be taken as the sole guide whereby to decide what wine is most suited to particular medical purposes; for the judgment of the taste and of experience cannot be neglected. Under all circumstances it is desirable that the physician should obtain a guarantee of the genuineness and purity of the wine he employs.

The chief effects of wine are, however, always to be attributed to the contained alcohol; besides this the proportion of sugar, of free acids, and frequently of tannin are to be noted. The last is present in large amount in the red wines only, so that for many dietetic purposes these are preferable to the white.[2]

[1] The figures relating to the mean composition of must and to the percentage of sugar and acid are taken from J. König, op. cit.

[2] When the first stormy fermentation is over, the wine is drawn into casks for the after-fermentation, where the yeast and the now insoluble salts, &c.,

In the following table the alcoholic strength, the free acid, the colouring matter, and tannin of the best known red wines are given, partly from means and partly from single analyses :—

	Alcohol, Vol. per Cent.	Free Acid	Tannin and Colouring Matter
Red Rheingau (mean)	10·08	0·52	0·16
Oberingelheimer, 1869	10·13	0·64	0·13
Assmannshäuser ,,	11·90	0·62	0·09
Red Hessianrhein wine (mean)	9·55	0·58	0·15
Ahr red wine (mean)	9·90	0·48	0·20
Alsatian red wine (mean)	11·15	0·43	—
Austrian ,, ,,	9·49	0·58	0·14
Vöslauer Goldeck, cabinet	10·28	0·59	0·15
Matzner, 1862	9·20	0·44	0·14
Ofner-Adelsberger, 1867	9·57	0·63	0·14
Erlauer, 1866	9·49	0·71	0·13
Vöslauer	9·89	0·57	0·13
Lustenauer (Tyrol), 1856	8·3	0·49	—
Swiss red wine (mean)	9·39	0·47	—
French red wines (mean)	9·07	0·59	0·22
Blaye, 1865	8·42	0·62	0·23
St. Julien, 1865	9·28	0·64	0·22
St. Estèphe ,,	8·32	0·68	0·21
Margaux ,,	9·44	0·63	0·23
St. Emillion ,,	8·71	0·64	0·21

J. Moleschott found in his official analyses a mean alcoholic strength for the red Bordeaux wines (clarets) 10·61 vols. per cent., for red Burgundy 11·19 vols. per cent., and for red Rhone wines 10·39 vols. per cent. The favourite, and apparently the best suited for constant use, are the French, and especially those of Bordeaux.

White wines are produced in greater variety than the red, especially in Germany, where the best districts—namely, the Rheingau

are gradually deposited. After the expiration of some months the clear wine is drawn off from the lees.

For the more complete clarifying of the wine, and for its better preservation, several methods are employed, of which Pasteur's process—warming in tightly-closed casks—is to be preferred; but the addition of isinglass or gelatin, as well as of milk or albumen and the like, is harmless enough. On the other hand plastering, as it is called, or the treatment of the wine with sulphate of lime, whereby a soluble sulphate of potash is formed, must be deemed injurious; and the same must be said of the addition of sulphuric acid, alum, certain red colouring matters, &c. Also every method employed for the improvement of a wine based on a lessening of the acid and an increasing of the alcohol and sugar may lead to injurious consequences by the introduction of salts, of alcohol containing fusel oil, and of impure sugar. For further information as to the manufacture and adulterations of wines see J. König.

—yield wines that in respect of delicate flavour (bouquet) cannot be surpassed.

In the following table are analyses of the best known kinds, as well as averages of the principal districts.

	Alcohol, Vol. per Cent.	Free Acid	Sugar
Rheingau (mean)	11·45	0·46	0·37
Marcobrunner, 1846	11·14	0·53	—
Rüdesheimer ,,	11·6	0·33	0·39
Geisenheimer ,,	12·2	0·40	0·43
Rauenthaler, 1834	12·1	0·48	0·28
Johannisberger, 1842	10·0	0·51	0·42
Mosel and Saar wine (mean)	12·06	0·61	0·20
Pisporter, 1848	10·8	0·58	0·52
Zeltinger, 1857	11·2	0·63	0·13
Scharzhofberger, 1857	14·2	0·56	0·15
Rheinpfälzer wines (mean)	11·55	0·53	0·52
Forster Auslese, 1846	11·5	0·48	0 57
Deidesheimer ,,	12·1	0·47	0·11
Ruppertsberger, 1848	11·5	0·46	0·57
Musbacher, 1842	10·5	0 50	0·53
Franconian wines (mean)	10·34	0·80	0·07
Leisten, 1871	11·02	0·66	0 01
Stein-Riesling, 1871	12·90	0·65	0·01
Spielberg mixed, 1847	9·0	0·91	—
Marschberg mixed ,,	7·6	1 14	—
Wines of the Bergstrasse (mean)	9·67	0·71	0·24
Alsatian white wines (mean)	10·14	0·52	0·09

These few examples may suffice to afford some general idea of the alcoholic strength of different wines more or less adapted for use as refreshing beverages.

The stronger wines of the South—the sweet wines and champagnes—can only be employed in small quantities; in larger doses their action is so energetic that they must be looked on as powerful stimulants.

The sweet liqueur-like wines with an alcoholic strength of 16 to 20 vols. per cent., or even more, are altogether artificial products, since in order to obtain the necessary stability spirit and sugar are largely added. The same must be said of the sparkling wines, in the preparation of which the wine, while fermentation is still proceeding, is put into strong bottles, sugar and spirit being added at the same time. Here fermentation continues, but the carbonic acid formed has no means of escape. The sediment resulting from this second fermentation is after some time removed by opening the bottles, and sugar and spirit again introduced. In the following table are analyses of several sweet and sparkling wines:—

	Alcohol, Vol. per Cent.	Extractives	Sugar	Free Acid
Tokayer Ausbruch, 1866	12·74	18·34	14·99	0·52
Ruster Ausbruch, 1872	11·08	23·64	21·74	0·51
Malaga, 1872	16·14	21·23	16·57	0·42
White port, 1860	20·03	8·83	4·88	0·54
Red port, 1865	21·91	8·83	6·42	0·45
Marsala	20·44	4·94	3·48	0·39
Madeira, 1870	19·11	5·22	3·46	0·48
Sherry „	22·90	3·78	1·88	0·44
Champagne (carte blanche)	11·75	13·96	11·53	0·58
Sparkling Rhine wine	12·14	10·88	8·49	0·57

In some countries the juices of other fruits than the grape, as those of apples, pears, currants, and gooseberries, are used for making wines. But, since these are poorer in sugar, syrup and perhaps also spirit are added to the expressed juice.

Apple wine, or cider, is that most extensively made; its alcoholic strength is on an average 5 to 7 vols. per cent.; it contains also a considerable quantity of acids, especially malic, of extractives, and of salts; to these constituents the mild aperient action of cider is doubtless owing.

The most alcoholic of drinks is brandy, including other spirits, so called, which are not obtained by the mere fermentation of saccharine liquids, but only by submitting the fermented liquid to distillation.

For the manufacture of spirits the material most largely used is potatoes; the raw product of the first distillation has, however, to be subjected to a further process of rectification, and even then is frequently not entirely free from amylic alcohol (fusel oil), which must be considered as most injurious. Better qualities are made from rye, maize, and rice, from molasses, crushed grapes, also from cherries and plums. The finest brandy is the French Cognac, which is distilled direct from wine or from fermented grapes; after it rank rum and arrack, of which the former is made from the sugar cane and the latter from rice.

These finer spirits have an agreeable, delicate flavour and odour, due to the presence of several ethers. By means of various additions to ordinary brandy a number of so called liqueurs of characteristic taste and odour are manufactured, the effects of which obviously depend on the nature of their very diverse ingredients.

The percentage of alcohol in the more common spirits varies between 45 and 60 per cent.; in cognac and arrack it often exceeds even this. Most liqueurs contain also a large amount of cane sugar and extractives of various kinds.

Unlike the pure spirits, which consist essentially of alcohol and water only, there is in beer a certain quantity of nutriments proper, as sugar, dextrin, and albuminates, which must be taken into account when we consider its action on the economy, although the general use of this beverage is not founded on the fact of their presence. Beer owes its value mainly to the alcohol it contains, although in smaller amount than other alcoholic beverages, as well as to its agreeable taste, to which the presence of carbonic acid contributes materially.

Besides the above-named constituents beer contains also bitter and resinous extractives of the hops, as well as glycerin, small quantities of acids, and ash. The oil of hops is the cause of the peculiar heaviness and drowsiness that often follows indulgence in beer, certainly in a greater degree than in the case of other alcoholic drinks.

In brewing beer malt—i.e. barley which has begun to germinate and has then been dried—is steeped in warm water; the wort is thus obtained, a solution of sugar, dextrin, albuminates, diastase, and salt. The wort is then boiled after hops have been added, cooled, and turned into vats for fermentation with yeast. Before the fermentation is completed the beer is transferred to large vats, to stand for a time, during which a feeble fermentation goes on.

According as a strong or weak wort is used is the beer more or less alcoholic. For lager or summer beer a more concentrated wort must always be employed than for winter beer, and a stronger wort still for the so-called double beers intended for exportation. The percentage of alcohol in different beers varies between 3 and 8 vols. per cent., the strongest being the English ale.

From a large number of analyses J. König gives the following mean composition of the several kinds of beer :—

	Water	Carbonic Acid	Alcohol	Albumen	Extractives	Ash
Winter beer . . .	91·81	0·23	3·21	0·81	4·99	0·20
Summer ,, . . .	90·71	0·22	3·68	0·49	5·61	0·22
Double ,, . . .	88·72	0·25	4·07	0·71	7·23	0·27
Porter and ale . . .	88·52	0·21	5·16	0·73	6·32	0·27

By standing the proportion of extractives gradually lessens, while that of alcohol rises.

The darker or paler colour of the different kinds of beer depends mainly on the temperature at which the malt is dried; the colour is also darker the longer the wort is boiled.

In place of barley other starchy materials, as wheat or rice, are occasionally employed for brewing; the so-called white beer, which is

always slightly turbid, foams strongly, and has a sourish taste, is made from wheat. The use of potato starch is to be deprecated, since it always yields amylic as well as ethylic alcohol.

Of late years methods of clarifying beer and giving it a greater power of keeping unchanged have been adopted, consisting in the addition of foreign and even of injurious matters, and many attempts have been made to find substitutes for hops in other and occasionally unwholesome bitter principles. But far more frequent than the actual falsification of beer by the addition of illegal ingredients is its deterioration at the retail houses by improper treatment, watering, &c.

Tea and Coffee.

These form a small group marked by the presence of an alkaloid, thein or caffein. The infusion of the roasted seeds of the coffee or of the dried leaves of the tea-plant yield aromatic beverages which, from their agreeable flavour and stimulating properties, have come to be general necessaries.

The coffee-beans are roasted by being exposed to a temperature of 200° C. or upwards, during which process they assume a brown colour, while aromatic, empyreumatic, volatile products are developed, which give to coffee its aroma, the sugar present in the beans being changed into caramel.

The proportion of caffein in the beans is not materially affected by the roasting; the action of the infusion depends, however, more on the ethereal oils generated during that process than on the presence or amount of the caffein. Coffee induces a certain stimulation of the nervous centres, lessened demand for sleep, acceleration and strengthening of the heart's action, with increase of the renal and cutaneous secretions. Moreover, coffee seems to stimulate the activity of the digestive organs, especially the peristaltic movements, so much so indeed that some persons find a cup of strong coffee sufficient to produce an evacuation. In unhealthy conditions of the gastric mucous membrane coffee is apt to excite unpleasant sensations of pressure and burning in the region of the stomach, whence for such cases tea appears to be decidedly preferable.

The fact that an excessive indulgence in coffee causes, besides other derangements, a diminished desire for food naturally suggested at first the idea that it diminished tissue waste, and might thus be employed for this purpose [as *Sparmittel*, a term which has no equivalent in English]. In opposition to certain experiments which seem

to lend support to this view Voit has shown that during the ingestion of coffee the excretion of urea is somewhat increased, a result sufficiently explained by its action on the circulation and nervous system.

There is not in the pure infusion of coffee any nutriment proper, although to cover the bitter taste it is not unusual to add sugar, and the habit of mixing it with milk is even more general.

According to the evidence of König the proportion of matters which in the usual process of making coffee pass into the infusion varies between 21 and 37 per cent. of the weight of the beans. On an average it gave—

Total Matters Soluble in Water	Caffein	Oil	Non-nitrogenous Extractives	Ash
25·5 p.c.	1·74 p.c.	5·18 p.c.	14·52 p.c.	40·6 p.c.

If now 15 grammes of coffee be used on a single occasion there will be contained in it—

Total Matters Soluble in Water	Caffein	Oil	Non-nitrogenous Extractives	Ash
3·82 grms.	0·26 grm.	0·78 grm.	2·17 grms.	0·61 grm.

Various substitutes, as chicory, acorns, date stones, &c., are employed, which though having little or nothing in common with genuine coffee are not on that account to be altogether condemned.

Tea and coffee resemble one another in their general action, a fact easily explained by their containing the same alkaloid; minor differences in their effects on the system are referable to the difference in the ethereal oils and to the larger amount of tannin in tea.

There is in tea a larger proportion of soluble matters, alkaloids and others, than in coffee. On on average air-dried tea contains—

Total Matters Soluble in Water	Thein	Other Nitrogenous Combinations	Non-nitrogenous Extractives	Ash
33·64 p.c.	1·35 p.c.	9·44 p.c.	19·20 p.c.	3·65 p.c.

If five grammes of tea-leaves are used for a single infusion there are contained in that weight—

Total Matters Soluble in Water	Thein	Other Nitrogenous Combinations	Non-nitrogenous Extractives	Ash
1·68 grm.	0·07 grm.	0·47 grm.	0·96 grm.	0·18 grm.

There are two principal classes of teas in commerce, the black and the green, besides some scented kinds. The black and the green teas are derived from the same plant, the difference in colour depending on the treatment of the leaves in drying. In general black tea is to be preferred, among other reasons because the green is more frequently adulterated.

Theobromin, an alkaloid allied to caffein, is found in the cacao bean, from which chocolate is prepared by the addition of sugar and spices.

Cacao beans deprived of their husks contain on an average, according to the analyses of J. König—

Water	Nitrogenous Substances	Fat	Starch	Other Non-nitrogenous Matters	Woody Fibre	Ash
3·25 p.c.	14·76 p.c.	49 p.c.	13·31 p.c.	12·35 p.c.	3·68 p.c.	3·65 p.c.

The percentage of theobromine is on an average 1·6 of the dry nut.

The beans lightly roasted are ground into a powder, from which a portion of the fat is removed before it enters the market. Such cacao powder usually contains still between 20 per cent. and 30 per cent. of fat, and is extensively mixed with starch or flour.

The mean composition of several of the best kinds of chocolate is thus given by J. König :—

Water	Nitrogenous Substances	Fat	Sugar	Other Non-nitrogenous Substances	Woody Fibre	Ash
1·55 p.c.	5·06 p.c.	15·25 p.c.	63·81 p.c	11·03 p.c.	1·15 p.c.	2·15 p.c.

It is thus seen that chocolate contains a large amount of non-nitrogenous food stuffs; it therefore acts as a stimulant in virtue of the theobromine and added spices, and as a true food from the quantity of sugar, fat, starch, &c. But the frequent addition of various foreign substances to chocolate calls for a certain caution in its use.

It has already been observed, when discussing the value of the mineral constituents of our food, that common salt plays an important part in the tissues, and still more in the juices, of the body, but that we are in the habit of taking far larger quantities than are needed to maintain the due proportion in the tissues or the normal performance of the vital functions. The excess serves as a condiment to the food, which without this addition would often be distasteful. Salt, moreover, if not in

too large quantity, acts as an aid to digestion, assisting the secretion of the gastric juice and the solution of the albuminates thereby.

The disintegration of albumen in the body is favoured by the presence of salt, and according to Voit the interchange of the juices is accelerated, as well as the renal secretion augmented. The increased elimination of water by the kidneys, together with the direct irritation of the sensory nerves of the throat, cause an intense sensation of thirst when large quantities of salt are taken. Still larger doses set up acute irritation of the gastric and intestinal mucous membrane and diarrhœa.[1]

These few remarks must suffice to show the great importance of salt, since it not only makes our food palatable, but, in common with other bodies of this class, fulfils several important functions in the body.

Vinegar finds a far less extensive use than salt, being chiefly employed to give to certain articles of food an acidulous flavour, and for the preservation of others.

Vinegar is, as a rule, prepared from liquids containing alcohol, which is converted into acetic acid by the action of a special ferment; the so called wood vinegar is obtained by the dry distillation of wood. The various vinegars prepared from wine, beer, and fruits contain, in addition to very dilute acetic acid, small quantities of sugar, dextrin, vegetable acids, various extractives, and colouring matters, besides apparently acetic ether. White wine vinegar is the most valued, on account of its delicate flavour and vinous bouquet. These kinds of vinegar contain from 2 to 7 per cent. of acetic acid, but in the so-called vinegar spirit, made from dilute alcohol, there may be as much as 14 per cent. present.

The vinegar obtained by the dry distillation of wood must undergo a special process for its purification before it can be used as such.

The addition of small quantities of vinegar to foods may somewhat aid the gastric digestion, but large quantities cannot but act injuriously. An excessive use of vinegar leads to a high degree of anæmia and emaciation, since the acid lessens

[1] See, besides the already cited treatise of C. Voit and J. Forster, C. Voit, *Untersuchungen über den Einfluss des Kochsalzes auf den Stoffwechsel*, Munich, 1860; Klein and Verson, *Sitzungsb. d. Wien.*, &c., vol. lv.; Bunge, *Zeitschrift f. Biolog.*, vols. ix. and x.; Falck, *Arch. f. path. Anat.*, vol. lvi.

the alkalinity of the blood and the number of blood-corpuscles. It is indeed not yet proved that such effects can be attributed to the ordinary dietetic doses, but there is no doubt that any excess may induce serious derangements of the digestive organs.

Besides those already mentioned many other substances are used as condiments, but, not having the like important action, may more easily be dispensed with. Such spices and condiments are as a rule used only in small quantities, but many of them contain, in addition to a mass of indifferent constituents, small portions of etherial oils and other aromatic substances.

To the last-named category belong, besides several already mentioned among the vegetable roots, chervil, salad Burnet (*Poterium Sanguisorba*), cumin, fennel, anise, coriander, thyme, marjoram, summer savory. From a dietetic point of view at least it does not appear that these condiments have any properties other than the taste and odour that they impart to the food.

A more marked action than those of the herbs just named is possessed by mustard and the exotic spices, as pepper, cinnamon, nutmeg and mace, cloves and allspice, ginger, saffron, and vanilla. All these spices not only possess a pleasing aromatic odour and taste, but assist the appetite and the digestion. An excessive use of them, however, leads to disorder of the digestive organs and serious irritation of the mucous membrane of the digestive organs.

PREPARATION AND COOKING OF FOOD.

The greater number of our foods are in their natural state by no means acceptable to the human palate, and many would present the greatest obstacles to mastication and digestion if experience had not found ways and means of removing the difficulty. Foremost among these is the culinary art, which by the action of high temperatures and appropriate combinations and additions not only prepares savoury dishes out of the raw materials of our food, but also provides for the necessary variety and change of gustatory impressions. In the processes of cooking changes are effected, both mechanical and chemical, which greatly lighten the labour of the organs of digestion.

In the dieting of the sick, among whom the necessity exists for the most easily digested food, the proper and careful preparation of the food is of the utmost importance, and it may frequently be observed that the very same article of food brings about quite different results according to the manner of its preparation. Unfortunately the scientific investigation of these matters has not as yet received the attention it deserves, although the necessities of the physician urgently call for it.

Cooking of Animal Foods, Preserved Meats, and Meat Extracts.

The methods of cooking flesh are very various; they have a great effect on its taste and may materially influence its digestibility.

In boiling meat the soluble constituents are to some extent washed out, a part of the soluble albumen, the extractives, and salts passing into the water. Some too of the fat is melted, and floats on the surface of the water, and lastly after long boiling more or less of the connective tissue is converted into gelatin, which dissolves out.

The extract of meat obtained by boiling constitutes beef tea or broth, which has from the earliest time played an important part in the dietary of the sick.

The proportion of soluble matters which pass out into the broth varies with the mode in which the boiling is conducted. When, for example, the meat is not immersed in the water until it is already boiling, a film or layer of coagulated albumen is formed over the surface of the meat, which protects it and prevents the washing out of the soluble constituents from its deeper portions. The broth thus obtained is thin and tasteless, containing only a small proportion of dissolved matters; the meat, on the other hand, remains juicy and palatable.

If the meat be placed in cold water, which is then gradually heated up to the boiling point, one gets a rich savoury broth, since in this way the whole joint is exhausted, and becomes tough, dry, and tasteless, the more so the longer the boiling is continued.

A rich broth and a palatable juicy joint cannot, therefore, be obtained from one and the same piece; so that it is found to be most advisable to prepare the bouillon from inferior pieces of meat with

bones; these are placed in cold water and boiled for a long time before the other portion, which is to remain juicy, is introduced and gently boiled just so long as may be required to make it tender.

In boiling the albuminates are coagulated and the connection of the muscular fibres loosened. The percentage of water in the meat is reduced, and in consequence of this abstraction of water, as well as the extraction of the soluble matters, a considerable loss of weight occurs, differing with the kinds of meat.

According to a calculation of Voit's 478 grammes of fresh raw beef, without bone or fat, yielded 271 grammes of boiled meat with 102·2 of dry solid constituents, and 1,145 grammes of broth with 21 grammes of solids; thus 100 grammes of raw meat yield 56·7 grammes of boiled, or 100 grammes of boiled correspond to 176 of raw.[1]

The following analysis by C. Krauch shows the relative composition of raw and cooked meat :—

In 100 parts of	Water	Nitrogenous Substances	Fat	Extractives	Ash
Raw meat . .	70·88	22·51	4·52	0·86	1·23
Boiled ,,	56·82	34·13	7·50	0·40	1·15

The clear broth always contains but a very small amount of nutritive matter, and so much the less when, as is the usual practice in households, the dissolved albumen is after its coagulation removed along with the greatest part of the melted fat in the process of skimming the soup. In such broths one finds, beyond the flesh salts and a small quantity of gelatin, scarcely anything but extractives, and their function is only that of relishes. That, notwithstanding this, broths are capable of doing good service, and that they do, for example, spur on the digestive organs to greater activity, needs, after the foregoing remarks on the value of relishes, no further explanation.

According to Wiel 500 grammes of meat treated in the manner indicated above suffice for the preparation of one litre of strong broth, the flavour of which will, as a rule, be improved by the addition of a few aromatic vegetables.

Meat extract, in the manufacture of which the meat is ex-

[1] C. Voit, *Gutachten über die Kost in den Volksküchen.*

hausted in cold water, so that neither gelatin nor fat passes out into the watery solution, has the same value as broth. To separate the albuminates the cold watery extract is heated to boiling and, the coagulated albumen having been removed by filtration, evaporated to the required consistence.

The American or Liebig's extract of meat contains on an average 20 per cent. of water, 22 per cent. of salts, and 58 per cent. of organic constituents. Among the latter are neither albumen nor gelatin, but merely the extractives of the meat; and indeed this follows alike from the permanency of the preparation, and from its price. Albuminates, and especially gelatin, are far more cheaply obtained than the pure meat extract, which consequently must not, as an article of trade, contain variable proportions of the less expensive substances.

In contrast with the American meat extract there are other preparations, especially the so-called soup tablets, which contain much gelatin; and even if the nutritive value of the latter were beyond question, supposing it to have undergone no decomposition, they must in money value come far behind the pure flesh extract.

Flesh extract finds its chief employment in the preparation and improvement of meat soups; it may also be used for the flavouring of other dishes. About 3 grammes of the extract are sufficient for a ration of well-flavoured soup.

Another variety of decoction of meat is much used, especially in England and America, under the name of beef tea; and from the ways in which it is made it contains not only extractives and salts, but also considerable quantities of albumen and gelatin.

According to Pavy beef tea should be prepared as follows :—A pound of lean beef is cut up as fine as possible and treated with cold water. When this cold infusion has stood for an hour it is to be kept for another hour in a closed vessel at a moderately high temperature, best of all in a gently boiling water bath. Lastly, the infusion is poured on to a coarse sieve, through which the beef tea runs. It contains a quantity of a fine precipitate, which is to be drunk with the liquid. Such beef tea has an agreeable and very pronounced flavour of meat, and salt may be added at pleasure.

Pavy considers it an error, though often practised, to boil the infusion for a long time on an open fire, since in this way a highly

gelatinous broth is obtained, but not a true beef tea, for the preparation of which a temperature of 76° C. is sufficient.[1]

Beef tea is also occasionally made as follows: Lean beef is cut up into small pieces, which are placed in a glass jar without the addition of water; the jar or wide-necked bottle is then closed and kept for several hours standing in boiling water: the meat juice that runs out gives a small quantity of a highly concentrated beef tea.[2]

The recognition of the fact that broths and meat extract contain but very small amounts of actual nutriment in no way lessens their value in the dietary of the sick. One must bear in mind that during the exclusive administration of broths the organism receives only stimulants and starves for want of food. So soon as a desire for actual food presents itself broths are no longer sufficient; they are, however, very well adapted for the preparation of really nutritious soups, in which the most diverse kinds of nutriment may be provided, and the advantage of an agreeable flavour may generally be combined with the fine division of the nutritive materials.

The culinary art has achieved its greatest triumphs in the preparation of agreeably-tasting soups, in which the most diverse kinds of nutriment and relishes, from both the animal and vegetable kingdom, are brought together. In general the more highly spiced soups, prepared with very different ingredients, are the least suited for invalids, and the simpler combinations are more to be recommended, as eggs, sago, rice, groats; also macaroni, pearl barley, toast, rubbed through a sieve, &c. In soups of these kinds the amount of nutriment obviously depends on the quantity and quality of the ingredients introduced.

F. Renk, in his enquiry into the diet of the Munich Hospital, gives from a large number of weighings the following means of the solids contained in single rations of the several undermentioned soups:—

	Grammes
Clear soup	264
Panadel soup	315
Egg and barley soup	322
Semolina soup	308

[1] F. W. Pavy, *A Treatise on Food and Dietetics*, p. 564. London, 1875.

[2] Another extract is met with in the market under the designation of 'Valentine's preparation of meat juice,' professing to be the juice of prime beef concentrated in vacuo at a temperature of 50°–55° C., and to be favourably distinguished from Liebig's extract of meat by containing a proportion of albumen. But, according to an analysis by J. Forster (*Zeitschr. f. Biol.*, vol. xii.), the quantity of albumen is very small and the value of the article is merely that of broth or of a very dilute flesh extract.

	Grammes
Rice soup	281
Cabbage soup	288
Barley soup	315
Custard	304
Sago soup	326

Renk also calculated from the quantity of the raw materials required for making a number of such rations, the amount of albumen, fat, and carbohydrates contained in each ration. Thus he found in—

	Albumen	Fat	Carbohydrates
Nudelsuppe [1]	2·9	4·2	13·2
Panadel soup	3·9	4·0	19·0
Rice „	2·0	1·0	19·0
Semolina „	2·5	3·6	11·6
Egg and barley soup	3·3	4·0	17·7
Sago soup	0·8	4·8	16·4
Custard	3·4	5·7	4·3
Pearl barley	2·8	2·8	17·9
Savoy soup	2·2	5·8	10·4
„ with toast	4·8	6·1	27·0[2]

But broth is not the only basis of soups; water, milk, wine, or beer, in which the most diverse articles may be boiled, furnish soups of every degree of nutritive value and digestibility, according to the materials employed.

In most soups the nutritive matters, and especially the albumen, exist not in solution but in a state of fine division;

[1] [Nudel is a sort of home-manufactured macaroni of flour and egg paste rolled and cut into strips.—TRANSLATOR.]

[2] For preparing the soups referred to in these tables the following raw materials were employed:—

Nudelsuppe, for 300 rations, 5,380 grammes of flour and 36 eggs.

Rice soup, for 373 rations, 7,550 grammes of rice, 12 eggs, and 3 litres of milk.

Panadel soup, for 293 rations, 9,125 grammes of semolina, 24 eggs, and 3 litres of milk.

Semolina soup, for 303 rations, 4,875 grammes of groats, 12 eggs, and 3 litres of milk.

Egg and barley soup, for 368 rations, 8,800 grammes of meal and 30 eggs.

Sago soup, for 360 rations, 6,700 grammes of sago, 24 eggs, and 4 litres of milk.

Custard, for 30 rations, 175 grammes of flour and 13 eggs.

Pearl barley for 384 rations, 6,000 grammes of barley, 3,050 gramme of flour, and 4 litres of milk.

Savoy soup, for 580 rations, 3,500 grammes of savoys, 7,500 gramme of meal, and 4 litres of milk.

it has therefore been attempted to extract from the raw meat by soaking and pressure the juices and nutritive matters dissolved therein, in order to provide the sick with albumen in a form more easily absorbed.

To these attempts we must refer Liebig's *infusum carnis frigide paratum*, known under the name of Liebig's beef tea.

For preparing Liebig's infusion of meat 200 grammes of lean beef, finely cut up, are treated with $\frac{1}{4}$ litre of water and 3 drops of hydrochloric acid until the meat has become quite white. After it has stood an hour it is passed through a hair sieve and the meat washed out with $\frac{1}{8}$ litre of distilled water. The fluid may now be gently warmed (to about 45° C.), but a stronger heat would coagulate the albumen, which would in like manner be precipitated by the addition of salt.

The taste of the infusion so resembles raw meat as to excite repugnance in most persons. But what most detracts from its value is the very small proportion—not more than 1 per cent. on an average—of albumen. The few drops of hydrochloric acid are quite insufficient to dissolve the myosin, so that the infusion must be looked on as an extremely dilute watery solution of serum albumen, and very large quantities indeed must be ingested to produce any appreciable effect on the system.

A much larger percentage of albuminates than in the *infusum carnis frigide paratum* is found in the *succus carnis recenter expressus*, which, according to the directions of Pettenkofer and Voit, is obtained by pressure from the raw muscle.

For the preparation of the fresh juice the meat is cut up and, having been arranged in layers separated from one another by coarse linen, is placed in a powerful press. From each kilo. of meat about 230 grammes of a blood-red acid juice are obtained. It contains, in addition to salts and extractives, all the albuminates that remain fluid after rigor mortis, chiefly therefore serum albumen and colouring matters, but the proportion of albuminates is about 6 per cent.

The succus carnis tastes exactly like raw meat, but the flavour may be improved by the addition of salt and of meat extract. If warmed too much the albumen is coagulated; but it is not precipitated by salt, as is the case with Liebig's infusion.

If one wish to administer the succus carnis it is best to prescribe it as a medicine in such a manner that the patient shall take the

juice of a kilo. of meat, i.e. about 14 grammes of dry albumen, in the twenty-four hours.

Of late years peptones have been artificially prepared in several ways, but mostly from muscle fibre, so that now it is easy to obtain them in sufficient quantities for the market. But to my mind a serious obstacle stands in the way of their extended use in the fact that these preparations, at least those best known to me, have a disagreeable taste, which cannot be covered by the addition of meat extract and the like.[1]

The peptones at present in the market have been evaporated down to the consistence of syrup, and are best given dissolved in broth or in some thickish vehicle, so that from one to two table-spoonfuls shall be contained in a cup.[2]

A somewhat high-priced preparation, under the name of fluid meat, two table-spoonfuls of which are stated to contain the nourishment of $1\frac{1}{4}$ lb. of cooked meat, has been accurately analysed by M. Rubner.[3] It contained 79·21 per cent. of solid constituents, and in 100 parts of the dried substance there were 81·36 organic matters, 12·61 sodium chloride, and 6·90 of other mineral matters; in the acid reaction of the solution preformed sulphuric acid could be proved. Of 100 grammes of the dried substance of the fluid meat only 49·1 consist of organic matters insoluble in alcohol, with 6·63 grammes or 13·5 per cent. of nitrogen. Of the nitrogenous constituents insoluble in alcohol 100 grammes of the dried fluid meat gave 41·9 grammes of peptone; the proportion, however, is in reality somewhat less, for other nitrogenous matters are contained in the alcoholic precipitate. The phosphate of Wolfram test gave a still lower valuation of the peptones, or not over 30·1 per cent. of the dried substance. Since two table-spoonfuls of the fluid meat weigh about 52 grammes, and contain 14·2 grammes of peptone, this quantity would represent 65 grammes of pure flesh.[4]

In order to avoid the objections attaching to nearly all peptone preparations hitherto offered and obtained by an arti-

[1] I may, however, observe that it would be a great mistake to suppose that an organism could be supported on peptones alone; for these consist of albuminates only, whereas non-nitrogenous substances are necessary for the nutriment of man.

[2] The best known of these preparations are the meat peptone of Sanders Ezn, in Amsterdam, and that made after the prescription of Adamkiewicz by Witte, an apothecary at Rostock.

[3] *Zeitschr. f. Biolog.*, vol. xv. p. 485.

[4] On the preparation of fluid meat see Edward Smith on *Foods*.

ficial gastric and pancreatic digestion, Leube and Rosenthal have employed a different process, in which the meat is exposed to a high temperature and dilute hydrochloric acid in airtight vessels.[1] Thus a portion of the meat is converted into peptones, while the rest forms an emulsion so fine that it can inflict no appreciable irritation on the mucous membrane of the digestive organs. The meat solution prepared in this way is, in my opinion, to be preferred to every other, and it has the special advantage that some of the albumen is still in an unaltered condition.[1]

To prepare this solution of meat according to the directions of Leube, 1,000 grammes of beef, freed from fat and bone, are finely chopped and placed in an earthen or porcelain vessel with 1,000 cc. of water and 20 cc. of pure hydrochloric acid. The porcelain vessel is then introduced into a Papin's digester, the cover of which is firmly closed and boiled for 10 to 15 hours, with occasional agitation in the first part of the time. At the end of the 15 hours the mass is taken out of the digester and rubbed in a mortar till it presents the appearance of an emulsion. It is then boiled for another 15 to 20 hours, without the lid of the digester being once raised, after which it is treated with pure sodic carbonate almost to neutralisation, evaporated to the consistence of a pulp, and divided into four portions, each representing 250 grammes of the meat. The solution is administered either pure or stirred in broth, and the need for carbohydrates met by the addition of crushed biscuit and milk. The taste of the meat solution may be still further improved by meat extract, &c.[2]

In roasting the nutritive juices and extractives are more completely retained in the meat than they are in boiling. In this method of cooking, the heat is applied immediately, without the intervention of water, or is brought to bear on the joint by means of melting fat, and by the coagulation of the albumen and evaporation of the water forms on its surface a sort of crust, which only partially permits the escape of the meat juices; these, together with so much of the fat as melts out, go to form the gravy, into which some of the gelatin passes when the high temperature is long maintained. A still higher

[1] Leube's dissolved meat may be obtained, in sealed tins, of Messrs. H. Poths and Co., 4 Sugar Loaf Court, Leadenhall Street.—(TRANSLATOR).

[2] *Sitzungsberichte d. Soc. physic.-med.*, Erlangen, July 29, 1872; also 'Ueber eine neue Art von Fleischsolution als Nahrungs- und Heilmittel bei Erkränkungen des Magens,' *Berl. klin. Wochenschr.*, 1873.

temperature leads to a browning of the surface, while several new odorous and sapid substances are developed, which give to well-roasted meat its characteristic odour and taste.

When the temperature of the interior of the joint does not rise beyond 56° C. this part has a reddish, bloody tint, and is said to be underdone. For beef, mutton, and some kinds of game this is generally deemed sufficient, since these meats are then most tender and palatable. Veal and poultry, on the other hand, should be more thoroughly done, but even here the temperature of the interior should not rise above 70° C. to 75° C., at which point the colouring matters of the blood are coagulated, since under a higher temperature the meat-fibre becomes horny and tasteless.

It may be easily understood that large joints yield a more juicy and savoury roast than smaller pieces, which can only be preserved underdone throughout by being kept for a short time in very hot fat, as is the practice in cooking beef steaks. Lean meats are apt to acquire a hard, dry crust when roasted, unless fat is added and the surface frequently basted.

The loss of weight that meat suffers in roasting, chiefly through the evaporation of the water, amounts on an average to from 20 to 24 per cent.

There are many other methods of cooking meat, in which it undergoes essentially the same changes as in boiling and roasting, the flavour of the different dishes and their relative digestibility depending mainly on the various adjuncts. An important part in this connection is played by sauces, in the composition of which, besides water and broth, fat and various condiments—flour, milk, wine, and vinegar—are employed.[1]

[1] It does not enter into the plan of this work to treat more fully, and in the manner of a dietetic cookery book, of all those particular ways of dressing meat which are either known or assumed to be specially suited to weak digestions, and therefore to supply particular wants, though the need for such instructions is often felt in practice. I will here merely mention that in the General Hospital at Munich a preparation of veal is often ordered along with roast meat, although veal, formerly recognised as a very digestible form of flesh, has of late been considered inferior to beef and mutton. The mode of preparation and the ingredients employed therein will soon enable one to form a judgment as to the circumstances under which veal thus prepared is more appropriate than roast meat.

The veal is salted, and then steamed for about an hour in a stew-pan with fat and green vegetables; the meat is then taken out, and the sauce

Fish is cooked in the same manner and for the like ends as meat, but there is no doubt that it is more easily borne and digested when boiled than when fried or stewed. Certainly fish fried in fat should only be offered to persons with perfectly normal digestions. The taste of fish is agreeable only when it is thoroughly boiled, but a much shorter time is required for this than is the case with meat.

In the discussion of this subject we cannot omit to mention some of the processes most frequently employed for the preservation of meat, since several of these involve certain changes in its constitution, which are not without influence on its digestibility and nutritive value.

One of the oldest methods of preserving meat is that of salting, a small quantity of saltpetre being usually added to the common salt, with a view to retaining the red colour of the flesh.

In the process of salting a part of the salts and extractives and a certain proportion—according to Voit a considerable proportion—of the albuminates are withdrawn from the flesh and pass out into the brine. But more importance attaches to the fact that pickled meats are strongly impregnated with the salt, and, besides the hardening of the muscular fibres thereby, much of the natural flavour is lost. The conditions under which the long-continued use of pickled meats leads to the development of scurvy cannot be further discussed in this place.

is prepared by boiling the broth in the pan with flour and a little vinegar. The meat, cut into small pieces, is next returned to the stew-pan, and the whole stewed together for a short time, with the addition of some cream, onions, and lemons. From the account of Dr. Renk there are used in the Munich Hospital for the preparation of 260 rations of the sauce 2,200 grammes of fat, 4,200 grammes of flour, and 500 grammes of sour cream.

Another dish, which on the score of fine division has an advantage over others, is known by the name of *hachée*, and is much enjoyed by the patients. Freshly boiled or steamed veal is minced fine and stewed with fat and semolina; then the sauce of veal broth, with wine and spices, but no vinegar, is added, and the whole boiled for some time longer. According to Renk 500 grammes of boiled veal, 50 grammes of fat, 50 grammes of flour or white bread crumbs, and 1,200 grammes of veal broth are used for making 9 rations.

I may in this place allude to still another preparation of veal which is much used in Munich and its neighbourhood, and seems well suited for invalids. It is the so-called veal sausage, for which raw veal and white bread crumbs are beaten together in a mortar until the mass acquires the consistence of dough. The sausages thus prepared are usually eaten boiled.

Frequently meat is salted only with a view to subsequent smoking, in which process it is impregnated with creasote and other constituents of the smoke, that bring about a coagulation of the albumen. At the same time the proportion of water in the meat is greatly reduced by the smoking.

The flesh of the hog seems to be better adapted for smoking than that of other animals, and long experience compels us to recognise smoked ham as one of the wholesomest forms of meat. Whether boiled or eaten raw, it seems as a rule to be more easily digested by weak organs than almost any other. It appears to me not improbable that the flesh becomes more digestible in the process of smoking; at least I have always found that even smoked breast of goose, notwithstanding its deep infiltration with fat, was fairly well digested, certainly far more so than roast goose. With some other kinds of flesh, and notably in the case of beef, the hardening and drying of the muscular fibres detracts much from the advantages of the smoking. The amount of water and the proportion of nutritive matters in smoked ham vary between pretty wide limits. On an average 100 grammes of ham give 30 of albuminates and 32 of fat; the salt ranges between 7 and 10 per cent.

Other methods of preserving meat, towards the perfecting of which such efforts are being made at present, have for their aim only the preservation and transportability, and no bearing on their dietetic applications.

The flesh of fish is in like manner preserved by salting or smoking as well as by steeping in vinegar or in fine oil. Many of these fish conserves are highly esteemed as delicacies; but such preparations are in general quite unfit for the sick, and must never be employed unless for some very decided purpose.

It has already been stated that the so-called offal, as blood, the viscera, &c., are no proper food for invalids; some of them, however, are of value so far as they serve for the preparation of gelatinous articles of food.

Well-prepared jellies, not containing too much acid or pungent spices, are very useful foods for invalids, and may be administered with advantage in febrile states. Unfortunately many persons have a strong aversion towards these dishes, which are regarded by others as great delicacies. Wiel gives a good receipt for a jelly which I know

to be very much used in diseases of the stomach, and made from calves' feet, ox feet, and an old hen, while the addition of a small fish renders it even more palatable.[1]

On the Cooking of Vegetable Foods.

The majority of vegetable foods are in their natural state quite inedible by man, and as with others which present no insuperable obstacles to the action of the gastric juice more or less complex processes are required to bring out of the raw materials palatable articles of food. For attaining this end mechanical subdivision and the action of high temperatures, by which the nutritive matters are set free through the bursting of the cell-membranes in which they are enclosed, are mostly used; the changes too which starch undergoes in dough are important.

One of the most important products of this class is without doubt bread, the want of which for any length of time is painfully felt by most persons.

In the process of baking certain chemical changes are set up in the dough by the action of the high temperature; the starch is partly converted into paste, and in the crust there are developed, along with dextrin and sugar, certain specific sapid substances. In addition a fermentation of the dough is set up, accompanied by the evolution of carbonic acid, the bubbles of which are held fast by the tough mass of the dough and give to the ultimate product of the baking a spongy, porous consistence.

As a ferment one uses either yeast, which decomposes the sugar present into alcohol and carbonic acid, or dough already in process of fermentation, the so-called leaven, which not only splits up the sugar into alcohol and carbonic acid, but also induces further fermentative changes, the products of which are acetic, butyric, and lactic acids. To this circumstance is due the fact that bread so made is, as a rule, marked by a more or less sour taste.

The raising of the dough may also be effected by the evolution of carbonic acid from the alkaline carbonates, as is the case when one uses the Liebig-Horsford's baking powder, a mixture of acid phosphate of calcium with sodium carbonate and potassium chloride.

[1] Wiel, *Diätetisches Kochbuch*, 4th edit. p. 103.

[The baking powders commonly sold, as Borwick's, are composed of tartaric acid and carbonate of soda, and are less wholesome than Liebig's.] Occasionally the 'raising' is effected by the use of bodies which are easily volatilised by heat, and thus inflate the dough, as ammonium carbonate [in Neville's so-called Welsh bread], or which hinder the escape of vapour, as, for example, the intimate mixture of the meal with fat.

Recently a process has been adopted for raising the dough in which the water used for mixing with the flour has been previously charged with carbonic acid under pressure. During the mixing, which is effected by an arrangement of tubes, the carbonic acid previously held in solution by the pressure escapes. [This method, first proposed by Dr. Dauglish, is now carried out by the A. B. C., or Aërated Bread Company.]

Bread presents great variation both in respect of its physical consistence and chemical composition, depending partly on the mode of preparation and partly on the characters of the meal employed. In many countries there exist peculiar methods of bread-making, so that the character of the bread may often be reckoned among the local characteristics of a district.

In respect of digestibility and nutritive value the various kinds of white bread, which are made of the finest flour with water or milk, have a decided advantage over the black breads; the latter vary much according as they are made from the finer or from coarse, adhesive rye meal. Such adhesive breads are indeed somewhat richer in nitrogenous matters than the finer kinds, but they are very imperfectly utilised by the human organs of digestion, since the irritation they cause to the mucous membrane of the alimentary canal leads to a rapid progress and early evacuation of its contents. This property is especially possessed by the so-called pumpernickel, which is, as a rule, made of entire, coarsely crushed grain with the help of sour dough. These kinds of bread may in many cases be usefully employed to overcome habitual sluggishness of the bowels.

The mean composition of the more usual kinds of bread, as well as of a few fancy articles which under certain circumstances may take the place of bread, is shown in the following figures :—

In 100 parts of	Water	Nitrogenous Matters	Fat	Sugar	Non-nitrogenous Matters	Woody Fibre	Ash
Fine fresh wheaten bread	38·51	6·82	0·77	2·37	40·97	0·38	1·18
Coarse „ „ „ .	41 02	6·23	0·22	2·13	48·69	0·62	1·09
English „ „ „ .	37·0	8·1	1·6	3·6	47·4	—	2·3
Fresh rye bread . .	44·02	6·02	0·48	2·54	45·33	0·30	1·31
Pumpernickel . . .	43·42	7·59	1·52	3·25	41·87	0·94	1·42
Fine wheaten biscuits .	1·18	13·31	3·18	7·12	73·96	0 25	1·0
Other biscuits . .	10·07	11·93	7·47	36·38	32 29	0·75	1·14
English „ . . .	7·45	7·18	9·28	17·02	58·08	0·16	0·83

According to Renk a Munich roll generally weighs about 50 grammes, and contains 4·8 grammes of albumen, 0·5 gramme of fat, and 30 grammes of carbohydrates.

In consequence of the more intense heat the changes in the constituents of the flour are carried further in the crust than in the crumb, whence it follows among other differences that there is always somewhat less nitrogenous matter in the crust than in the crumb. After long keeping bread looks as if over-baked—i.e. it becomes hard, owing, in Bibra's opinion, to the water entering into chemical combination with the solid constituents; for when stale bread, if it has not been kept too long, is warmed to about 70° or 80° C. it again appears fresh and new, which would be impossible had its hardening been really due to evaporation of the contained water.

For special dietetic purposes, particularly the treatment of diabetes, Bouchardat suggested the use of a bread made from gluten, several kinds of which are now to be had. But, to say nothing of the fact that gluten bread always contains a certain amount of starch, its extremely unpleasant taste will always be an insuperable objection in the way of its continued employment as a substitute for the ordinary palatable kind. On these grounds the almond bread recommended by Pavy and Seegen, which is made from almonds (after exhaustion with boiling water) and eggs, seems to us far more likely to prove a true substitute, and even cakes or biscuits prepared from the meal of legumens would be preferable to gluten bread.[1]

It has been already mentioned that the meals prepared from cereals and leguminous plants are frequently used in combination with eggs and as adjuncts to soups, and that the foods thus prepared present the advantage of being already in a state of

[1] Cf. Senator, 'Diabetes mellitus,' in V. Ziemssen's *Handbuch d. spec. Path. und Therapie*, vol. xiii. 1, 2nd edit.

fine subdivision. Quite recently F. Penzoldt has endeavoured to obtain from vegetable sources peptonised soluble albuminates, capable of direct absorption without being previously reduced to the soluble state by the action of the digestive organs.

According to the directions of Penzoldt for preparing a peptonised solution of vegetable albumen, one takes 250 grammes of the finest possible pea meal, 0·5 gramme of pepsin, and 1 gramme of salicylic acid. The last checks the fermentative changes which the use of hydrochloric acid might set up.

This digestive mixture is allowed to stand in a warm place at a temperature not exceeding 38° C. (100° F.) for about twenty-four hours, and then strained through fine linen, which does not permit the passage of the starch. Thus prepared it has a taste resembling pea soup; before serving it is gently warmed in a water bath, with the addition of a little salt and spice or of some meat extract.[1]

Of far less importance than bread are the other bake meats known as cakes, tarts, pasties, &c. In their preparation the constituents of the flour undergo similar changes to those which occur in baking bread; the raising of the dough is effected either by means of yeast or of fat, alcohol, carbonate of ammonia [baking powders], or beaten egg albumen. In other respects these bake meats are of the most various qualities and composition; in their manufacture flour, milk, fat, sugar, eggs, fruits, &c., are employed, so that no general rules can be laid down as to the wholesomeness.

In contradistinction from the above-named bake meats one is accustomed to distinguish as farinaceous foods in a more limited sense certain preparations in the composition of which meal of some kind is the essential ingredient, cooked with water alone, or with milk, fat, eggs, sugar, &c. In general these preparations have a less solid consistence than the bake meats proper, and are on that ground among others to be preferred for weak digestions.

Among the simplest of these are the gruels and similar prepara-

[1] 'Pflanzenpeptoneiweisslösung und deren Verwendung zur Krankenernährung,' *Deut. med. Wochenschrift*, 3rd year.

As condiments Penzoldt recommends the spice extracts prepared by L. Naumann, of Dresden Plauen, and especially his so-called 'Fleischgewürzsalz.'

tions of meal, groats, rice, or macaroni boiled in milk. These provide in many cases a very useful nutriment, especially as a transition from fluid to more solid foods, and the objections rightly urged against the use of gruel as food for infants do not hold good for after-life.[1]

Another description of farinaceous food, which both in respect of its form and composition is as a rule as easily digested, is known in Germany by the name of 'Auflauf.' The most usual ingredients are meal, milk, eggs, and sugar; but rice or groats are often substituted for meal.[2]

Many puddings too are easily digested and utilised, but there are receipts in cookery books for puddings which are not only quite unfit for invalids but would tax the powers of a healthy stomach. The same may be said of dumplings, which may be so prepared that they may be given to the feeblest convalescent without ill results, whereas others of the same name would demand the most energetic digestion.[3]

Most other kinds of farinaceous foods call for a more or less normal condition and activity of the digestive organs, and can therefore be indulged in safely only when the actual form of the food administered is of subordinate importance.

The greater number of green vegetables must also be submitted to a more or less energetic process of cooking.

[1] F. Renk, in his enquiry into the dietary of the Munich Hospital, found that for 8 rations of thick milk there were used 180 grammes of meal, 2·5 litres of milk, and 8 grammes of sugar; each ration therefore contained 15·4 grammes of albumen, 12·4 grammes of fat, and 30·7 grammes of carbohydrates. The proportions for other preparations of the same class were:—

	Albumen	Fat	Carbohydrates
1 ration rice milk . .	13·6 grms.	9·8 grms.	41·7 grms.
,, gruel . . .	9·2 ,,	7·6 ,,	24·6 ,,
,, macaroni in milk .	16·5 ,,	9·4 ,,	31·0 ,,

[2] According to Renk 5 rations of *Auflauf* at the Munich Hospital are made with 70 grammes of groats, 40 grammes of sugar, 500 grammes of milk, and 5 eggs. Each ration, therefore, contains 12·1 grammes of albumen, 8·7 grammes of fat, and 22 grammes of carbohydrates.

[3] In the Munich Hospital dumplings are very generally provided with the sauce served with prepared (*eingemachtes*) veal, *hachée*, &c., and, according to Renk, 200 grammes of rubbed semolina, 3 eggs, 70 grammes of fat, and 250 grammes of milk are used for making 15 dumplings; one ration, therefore, consisting of two such dumplings contains 2·1 grammes of albumen, 3·5 grammes of fat, and 6·3 grammes of carbohydrates

Indeed in their case as much or even more than in that of other vegetable foods does it depend on the mode of cooking whether any particular article may be considered wholesome or not.

Since vegetables constitute an important adjunct to animal foods, serving among other uses to vary the impressions of taste, their selection and preparation deserve no small attention. They should be young and tender, and boiled long enough to acquire the necessary degree of softness. It is also generally desirable that they should be more or less finely divided.

As a rule gravy and fat, frequently too some meal, are added as a dressing to cooked vegetables. Some of them give off to the water in which they are boiled ill-smelling and pungent matters, rendering it necessary that the first water should be poured away.

As tasty adjuncts to animal dishes the leguminous vegetables are less useful than the roots or leaves. As regards digestibility, cauliflower, asparagus, and scorzonera stand first; to a certain extent carrots [?] and kohl rabi, peas and spinach may be deemed easy of digestion; of the various ways of dressing potatoes only the so-called *purée* can be recommended. With the exception of cauliflower the cabbage tribe demand a good digestion. By many white cabbage is considered fit for feeble stomachs only in the preserved or fermented state, the so-called 'sauerkraut,' but other beneficial actions are ascribed to it, and it is especially celebrated as an antiscorbutic.

Salads, much esteemed as adjuncts to joints, fulfil the same ends as warm vegetables. In their preparation numerous vegetables are used, some boiled, others fresh, with oil and vinegar mixed as intimately as possible and suitable condiments. Besides the salad plants properly so called cucumbers, radishes, green beans, asparagus, the young sprouts of hops, potatoes, beetroot, &c., are used in salads. There are, too, compound salads, into the composition of which not only vegetables but cold meat, herrings, sardines, &c., enter. The quantity both of oil and vinegar, as well as the fact that a great part of the vegetables are in the raw state, clearly point out all such dishes as inappropriate for invalids.

Several fruits, as melons, pine apples, &c., as well as our own garden fruits, are as a rule eaten raw, partly at least because their delicate aromas and flavours would be dissipated in the process of cooking. Fruits are also better calculated in the raw condition to exert on the alimentary canal certain actions

that are occasionally desired, but for the sick table in the narrower sense cooked or preserved fruits alone are as a rule really suitable.

Apples and pears, peeled and cooked, the so called *compotes*, make very wholesome dishes, pleasant and refreshing. Cherries and quinces may be employed in the same way. The same is true of jams and jellies, as those of raspberries, currants, and cranberries. On the other hand, in using these and like berries in the condition of preserves, great care is requisite to avoid the hard skins and seeds. The expressed juices of fruits also serve as relishes in many ways, and some of them exert decided medicinal actions at the same time.

DIGESTION AND UTILISATION OF NUTRIMENT.

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The digestive process as begun in the oral cavity consists in a mechanical subdivision of the solid parts of the food, and their thorough permeation by the fluids of the mouth. The mixed saliva of man possesses too in a high degree the power of converting the insoluble starches into soluble carbohydrates, the salivary ferment splitting them into two distinct bodies, dextrine and ptyalose (salivary starch sugar).[1]

One may well doubt if the diastatic action of the saliva in the mouth itself can be brought to bear on the food to any considerable extent, during the short time it is retained there. It must, however, be remembered that the action of the human saliva is very energetic, indeed almost instantaneous; besides which one must admit that it may be continued within the morsels of food after they have been swallowed until the gradually increasing acidity of the ingesta interrupts it.[2]

The processes within the oral cavity by which the food is prepared for the further actions of the digestive organs may be influenced in several ways by pathological conditions interfering with the ingestion or the due comminution of the food; the fluids of the mouth may also present various deviations from the normal both in quantity and quality. Furthermore anomalies in the sensation of taste are of frequent occurrence, in consequence of which the desire for food and the reflex excitation inducing the secretion of saliva may be diminished.

One of the most frequent changes in the fluids of the mouth, met with in the course of very different morbid conditions, but most often in febrile states, is an acid reaction in place of the normal alkaline character of the saliva. In some rare cases the glands themselves yield an acid secretion, but far more frequently this reaction takes place in the mouth, in consequence of fermentative and other changes set up by low organisms developed in the mouth.[3]

[1] Musculus, *Journ. d. Pharm. et Chim.*, 3rd ser. xxxvii.; *Chem. Centralblatt* 1860, p. 603; O. Nasse, *De Materiis Amyl.*, &c., Halle, 1866, and *Arch. für Physiol.*, xiv. p. 474; E. Brücke, 'Studien über die Kohlehydrate u.s.w.,' *Sitzungsbericht d. Wien. Akad.*, sect. iii. p. 126, vol. lxv. 1872.

[2] Paschutin, 'Einige Versuche mit Fermenten u.s.w.,' *Arch. f. Anat. u. Phys.*, part iii. p. 305, 1871.

[3] Mosler, 'Untersuchungen über d. Beschaffenheit d. Parotidensecretes

Not less often in febrile states with elevation of the general temperature of the body, and in the presence of local inflammations of the oral cavity, do we find a diminution of the salivary secretion, and with it a lessened production of mucus. The consequences of an abnormal dryness of the mouth in respect of the reception of food, the sensation of taste, the feeling of thirst, &c., are too well known.

In other cases the secretion of mucus is not diminished, and may even be increased, but it acquires an abnormal viscidity and is unusually rich in cellular elements, so much so that it is no longer fitted for moistening the cavity of the mouth or the food. Besides, this condition of the oral fluids is most favourable to those decompositions which lead to an acid reaction of the saliva, fœtor of the breath, &c.

An increase of the salivary secretion may follow irritations and inflammations of the mouth of the most various kinds, and may also be induced by direct excitation of the centres controlling the nerves of the secretory glands. A moderate increase of this secretion cannot have any very marked influence on the processes of digestion, but, on the other hand, very high degrees of salivation can hardly be without injurious consequences. But that the emaciation which is sometimes seen to accompany extreme salivation is solely or mainly the result of the excessive secretion and the consequences arising therefrom is, to say the least, doubtful.[1]

In the several pathological changes of the oral fluids their diastatic action may suffer either by there being no true ferment formed or by its being too highly diluted. This is the case in excessive salivation, when the secretion differs little from water. In such extreme dilution of the saliva it follows that its action on the starchy foods is very soon overpowered by the acidity of the gastric juice. The fermentation of the saliva may also be weakened by the presence of free acid in the mouth, though this circumstance alone can scarcely be of material importance.

u.s.w.,' *Berl. klin. Wochenschr.*, Nos. 16, 17, 1866; Grawitz, 'Beiträge zur system Botanik der pflanzl. Parasiten u.s.w.,' *Virch. Arch.*, vol. lxx. p. 546; also, 'Stellung des Soorpilzes in d. Mykol. d. Kahmpilze,' ibid. vol. lxxii. p. 147; compare also Uffelmann, l.c.

[1] See Bamberger, also Cohnheim, l.c.

In very high degrees of salivation digestion may be deranged in still another way, the large volumes of alkaline saliva entering the stomach diluting and neutralising the gastric juices. The stomach too is unduly distended with the great quantity of saliva and of atmospheric air swallowed with it, and various discomforts, loss of appetite, and vomiting are induced.

Since the food undergoes no further chemical changes in its passage from the pharynx to the stomach functional derangements of the act of deglutition can only affect the ingestion of food mechanically. This interference may, however, be carried so far that the requisite amount of food can no longer be taken by the natural ways, and recourse must be had to artificial feeding.

Further changes and alterations of a more radical character than those we have considered take place in the stomach, and foremost among those is the conversion of the albuminates from the insoluble into the soluble modification by the action of the gastric juice.

The mucous membrane of the stomach possesses, according to Heidenhain, a threefold secretory apparatus—namely, the cylindrical surface epithelium, the pyloric glands, and the glands of the mucous membrane of the fundus.

The surface epithelium covers the free surface and lines the crypts of the mucous membrane, and is especially the seat of the secretion of mucus, the protoplasm of the cells undergoing successive mucous metamorphoses.

The pyloric glands are ducts lined with a single layer of cylindrical cells. These gland cells, however, exhibit, according to Heidenhain and Ebstein, relations essentially different from those of the surface epithelium, especially in regard to micro-chemical reagents, whence we may reasonably infer a difference in function between the two forms of cells. The pyloric glands were formerly looked on as simple mucous glands, whereas, according to Heidenhain and his disciples, they furnish a tough, slimy, alkaline secretion, which both in its behaviour with reagents and in its physiological action is sufficiently distinguished from the proper gastric mucus.

The glands of the fundus have the same duct-like character and exhibit two kinds of cells, one of which presents a great similarity to those of the pyloric glands and line the whole interior of the ducts. whence they are called by Heidenhain *Hauptzellen.* The second

class of cells lies outside of the former, covering the membrana propria with an unbroken layer, and presents an oval or triangular, finely granular and highly albuminous appearance; they are the peptic cells of the early writers, the basement cells (*Belegzellen*) or supporting cells of Heidenhain. The fundus cells yield the gastric juice proper, and indeed the researches of Heidenhain and his pupils render it more than probable that each class of cells in the gland fulfils a separate function in the production of the gastric juice.

The most important constituents of the gastric juice are the so-called pepsin and a free acid to which is due the intensely sour reaction of the secretion. Since the investigations of C. Schmidt there can be no doubt that the acid of the gastric juice is hydrochloric, and that when lactic, butyric, or acetic acids are found in the stomach they are always to be viewed as products of the decomposition of the carbohydrates of the food.[1] Formerly the so-called peptic glands were looked on as the exclusive seat of the formation alike of the pepsin and of the acids of the gastric juice, until the labours of the physiologists of the Breslau Institute showed that the pyloric glands share in the secretion of pepsin, and that in the glands of the fundus the 'central' cells (*Hauptzellen*) yield pepsin and the basement cells (*Belegzellen*) the acid of the gastric juice.

Pepsin, and probably also the acid of the gastric juice, is to be viewed as a product of certain chemical processes in the cells of these glands, which elaborate the materials brought to them by the blood, without themselves undergoing destruction, as was formerly thought.

The materials for the formation of pepsin are clearly albuminous substances received by and elaborated in the 'central' cells (*Hauptzellen*) and those of the pyloric glands, and discharged into the stomach as a ready-made ferment during the functional activity of that organ. According to the observations of Heidenhain and his pupils the formation of pepsin takes place most actively during the periods of rest and the early stages of digestion. During the later stages the consumption of pepsin exceeds its secretion, and the albuminous materials are stored up in the cells. These processes, which may be recognised alike in the relative amount of pepsin contained in the mucous membrane at any time and in the microscopical

[1] In p. 50 it was pointed out that the gastric mucous membrane yields, besides pepsin, two other ferments, a lactic acid ferment and one which has the property of splitting up casein.

characters of the gland cells, do not proceed *pari passu* in the cells of the fundus and pylorus, but are somewhat more tardy in the latter.

The chlorides of the blood must be looked on as the material for the formation of the hydrochloric acid, the alkali set free being usually excreted in the urine.[1] But as to the mode in which this breaking up of a neutral salt is effected we can only conjecture. Formerly it was considered sufficient to assume a metabolic action of the gland cells, and at present it is the opinion of many that lactic acid is first formed in the stomach, which, combining with the alkali of the chlorides, sets free the acid. Maly was the first to call in question the view that the primary acid was an organic one, and that the secretion of free hydrochloric acid in the peptic glands was to be explained by an interchange among the salts of the blood serum. He brought forward evidence that the phosphates present in the blood were capable of forming hydrochloric acid from the sodium chloride; and the passage of the acid into the gastric juice is due, in Maly's opinion, to its property of great diffusibility through membranes.[2]

The secretory action of the gastric mucous membrane is not continuous; it is especially evoked by stimulants of any kind. Accordingly the mucous membrane appears when at rest pale and bathed in mucus, but during digestion it assumes a bright red hue. To the question whether the normal stimulation of the gastric mucous membrane by the ingesta is purely a mechanical effect, or at the same time a chemical one, Heidenhain replies that the character of the ingesta exerts an influence both on the extension and the intension of the secretion of the highest importance. The secretion induced by merely mechanical irritation is scanty and confined to the spots thus directly irritated, whereas the reception of digestible food puts the entire mucous membrane into a state of sustained activity.[3]

[1] After a heavy meal, or after withdrawal of the gastric juice by means of a fistula or by washing out the stomach, the urine may acquire an alkaline reaction. Compare Maly, *Annal. d. Chemie*, clxxiii. 1874; Quincke, *Correspondenzblatt f. Schweizer. Aerzte*, 1874, No. 1.

[2] Maly, *Bericht der D. Chem. Ges.*, 1876, p. 164; *Zeitschr. f. phys. Chem.*, i. p. 174, 1877.

[3] Heidenhain infers from this that only very small quantities of gastric juice can be obtained by mere mechanical irritation of the gastric mucous membrane through fistulæ. Accordingly it was observed that in a dog with an isolated *cul de sac* of the fundus only a scanty and transient secretion followed

An active secretion of gastric juice is excited by dilute alcohol and by dilute solutions of common salt or of carbonate of soda, as well as by the various spices and condiments. On the other hand these substances, in a concentrated form, cause the secretion of a neutral or alkaline albuminous fluid.

The fact that the secretion of the gastric juice follows only on particular forms of stimulation is most simply explained by assuming the existence of secretory nerves, put in action in a reflex manner, as in the case of the salivary glands. This supposition is not negatived by the fact that section of the nerves entering the stomach from without, viz. the vagus and sympathetic, does not suspend the secretion of the gastric juice, since there are numerous ganglia in the mucous membrane of the stomach itself. Experience shows too that certain states of stimulation are communicated to the hypothetical secretory nerves of the gastric glands otherwise than through the sensory nerves of the mucous membrane of the stomach; thus it has been observed through gastric fistulæ that under certain conditions even the sight of food called forth a secretion of gastric juice.

Since it has as yet been impossible to demonstrate the existence of these secretory nerves in the mucous membrane, Heidenhain has suggested the possibility of a direct mechanical irritation of the glands themselves, just as in plants the act of secretion may be excited by mechanical means without the intervention of nerves.

By the action of the gastric juice the various albuminates are, perhaps after passing through intermediate stages, ultimately converted into peptones, which are peculiarly adapted for absorption, since they are very soluble in water and form easily diffusible solutions. The peptones are considered by many authorities as the normal termination of the digestion of albuminates in the stomach, and as resulting from the conjoint action of pepsin and the acid. The so-called neutralisation precipitate, or parapeptone, is certainly to be reckoned as an intermediate product; it may be obtained by the action of acids

the introduction of indigestible elastic tissue, whereas an abundant and sustained secretion was called forth by a meal of digestible food. See *Physiol. der Absonderungsvorgänge*, p. 114.

only without the help of pepsin, and is identical with syntonin or acid albumen.[1]

For the peptonising of albumens it is not merely necessary that pepsin and acid should be present in the gastric fluid, but these two active factors must be in certain proportion the one to the other; especially must the proportion of acid not exceed or fall below certain limits if the transformation is not to be seriously affected and ultimately altogether arrested.

Since the several albuminates require different quantities of acid for their speedy solution, it is impossible to determine with what degree of acidity the strength of the gastric juice is greatest under all circumstances. It has been ascertained that the solution of fibrin takes place with the greatest rapidity when the proportion of acid in the gastric juice amounts to 0·8 to 1 per 1,000 of milk, while the digestion of boiled white of egg is most active with 1·74 per 1,000. C. Schmidt found in human gastric juice only 0·2 per 1,000 of acid; but Hoppe Seyler does not believe that good human gastric juice can be so dilute, and states that Szabo found in the contents of the stomach of a man suffering from dilatation of that organ as much as 3 parts per 1,000 of hydrochloric acid.[2]

Pepsin, indeed, in combination with the most diverse acids, gives digestive fluids capable of dissolving albumen. No acid, however, acts so energetically as the hydrochloric, next to which come nitric, lactic, and phosphoric acids. As in the case of hydrochloric so also with each of the other acids there exists a certain percentage at which the solution of the albuminates proceeds most rapidly, a larger proportion of these appearing to be necessary than of hydrochloric.

A small quantity of pepsin is capable of converting a large amount of albumen without being itself in any way altered; indeed the loss of pepsin during digestion seems to be mainly due to its passage from time to time into the small intestine along with the chyme. An energetic action of the gastric juice demands nevertheless the presence of a suitable quantity of pepsin, but the solution of albuminates is accelerated only within narrow limits by increasing the proportion of pepsin in

[1] By long-continued action of the gastric juice still further splitting up of the albuminates takes place, with the production of tyrosin, leucin, and other as yet undefined bodies (Hoppe Seyler, *Die Verdauung*, p. 228).

[2] Hoppe Seyler, ibid. p. 220.

the digestive fluids, any further addition of pepsin having apparently no power to increase the activity of digestion.

For the proper performance of gastric digestion it is absolutely necessary that the ingesta should remain for some considerable time in the stomach, there to be intimately mixed with the gastric juice by the rhythmically recurring movements of that organ. The retention of the food in the stomach is effected by closure of the pylorus, while peristaltic movements of the walls bring about a gradual mixing and penetration of the food mass with gastric juice.

Our knowledge of the nature and extent of the movements of the stomach is as yet very imperfect. From several observations it would seem that the pylorus is usually closed by the tonic contraction of its circular muscles in the manner of a sphincter, and that only in consequence of its occasional relaxation are the contents of the stomach able to pass into the bowel. In the earlier stages of digestion the opening of the pylorus seems to be only momentary, and not till late in the process are any large volumes of chyme allowed to pass out, a result connected by Brücke with the greater acidity of the contents of the stomach.

As a result of the peristaltic contractions Beaumont observed a movement by the food from the cardia to the *cul de sac* (fundus), and thence along the greater curvature to the pylorus, whence it was conducted along the smaller curvature to the fundus. But a movement of this description and regularly repeated has not been constantly observed in stomachs artificially exposed.

From experiments on the influence of the nerves entering the stomach S. Mayer concludes that motor impulses can be conducted to the stomach by the vagus and the sympathetic alike. At the same time it is well established that section of the branches of the vagus does not arrest these movements; on the contrary, Goltz observed in the stomach of the frog increased contractions follow the division of this nerve, which would seem to indicate that inhibitive influences were conveyed by way of the vagus to the ganglia in the walls of the stomach.

Besides the albuminates proper gelatin and gelatiniferous tissues must be considered as objects of gastric digestion. Gelatin under the action of gastric juice loses the property of solidifying in the cold, a change which may be effected by hydrochloric acid alone, though the presence of pepsin appears

to accelerate it. The products of the digestion of gelatin, the so-called gelatin peptones, are quite different bodies from the peptones proper, though like them soluble in water and diffusible through membranes.[1]

As regards the changes that starch undergoes in gastric digestion it was formerly generally held that, though the diastatic action of the saliva might be prolonged for some time in the stomach until the acidity of the gastric juice arrested it, no further transformations were effected in starch during its stay in the stomach. Lately, however, Brücke has maintained that during gastric digestion large quantities of soluble starch and of erythrodextrin are formed. The formation of soluble starch is mainly brought about by the acidity of the gastric juice, while the conversion of starch into erythrodextrin is in great part effected by a process of lactic fermentation. According to Brücke there can be no doubt as to the constant presence in the stomach of the ferment by which the sugar of the food is converted into lactic acid, but with starch large quantities of erythrodextrin are formed at the same time; indeed this change takes place of itself even when the acidity of the stomach is such as to check the further action of the saliva. Lactic fermentation, according to Brücke, is not a casual change of the contents of the stomach, but an important aid to the transformation of starch; extreme degrees of acidity do not occur unless a great excess of sugar be present in the stomach.[2]

No further changes in the food having any influence on its absorption take place in the stomach, and the digestion of fat is exclusively intestinal.

From numerous experiments it appears that the solution and peptonising of the various forms of albumen by means of acid pepsin and under conditions similar in every respect requires very various periods, and are performed with different

[1] Comp. for the digestion of gelatin Im. Thurn; Moleschott's *Untersuch. z. Naturlehre*, vol. v. p. 315; Metzler, *Beitr. z. Lehre von der Verdauung des Leims*, Diss., Giessen, 1860; Meissner, *Zeitschr. f. ration. Med.* iii. R. vol. xiv. p. 311; Tatarinoff, 'Zur Kenntniss z. Glutinverdauung,' *Centralbl. f. d. med. Wissensch.*, 1877, No. 16; Uffelmann, *Deutsch. Arch. f. klin. Med.*, vol. xx. p. 535.

[2] E. Brücke, 'Studien über die Kohlehydrate u.s.w.,' *Sitzungsber. d. Wien. Akad.*, 1872, vol. lxv.

degrees of completeness. According to Maly the different behaviour of the albuminates as regards the action of the gastric juice is to be explained chiefly by the different action of the acids alone on the digesta.

We possess many observations on the behaviour of blood fibrin towards the gastric juice; in a fresh state it is extremely soluble, but somewhat less so, according to Frerichs, when it has been previously boiled.

If we accept the view that the soluble albuminates are capable of being absorbed without further preparation, it is superfluous to speak of their digestion. But the majority of observers maintain that these albuminates must without exception be converted into peptones before they can be absorbed, and it is even possible that this process of transformation may be longer in completion in the case of the soluble than of the insoluble forms. As a matter of fact Meissner found that coagulated albumen was more easily converted into peptone than was the liquid form. Fick could not detect any decided difference,[1] and Wawrinski concluded that, on the whole, when the acidity of the gastric fluids was moderate more peptone was produced from boiled than from liquid egg albumen, but that when the acidity was more marked the opposite proportion obtained.[2] The notion of Prout, Beaumont, and others that soluble egg albumen is first coagulated in the stomach and then again dissolved has been refuted by Frerichs.

The casein of milk is quickly dissolved by the acid of the gastric juice, but is at first reprecipitable by neutralisation. After a more prolonged action of the digestive fluid it appears as a sort of jelly, which still later is again dissolved, leaving a pasty residue (Meissner's dyspeptone).[3]

Vegetable albumen, according to Frerichs, behaves towards the gastric juice precisely like the animal kinds.

Vegetable casein is, according to the researches of Cnoop Koopmans, easily soluble in dilute acids; when boiled it is, on the contrary, soluble in gastric juice only, and for this a relatively higher degree of acidity is required than for the solution of egg albumen under the most favourable circumstances.

[1] A. Fick, 'Beitr. zur Pepsinverdauung nach Versuch. von Drewke u. Goldstein,' *Verhandlungen d. phys.-med. Gesellsch. in Würzburg*, 1871, New Series vol. ii.

[2] R. Wawrinski, 'Ueber die Löslichkeit des geronnenen und flüssigen Eiweisses im Magensafte,' *Jahresber. über die Fortschritte d. Thierchemie*, vol. iii. p. 175.

[3] Compare Maly, *Chemie d. Verdauungssäfte u.s.w.*

Gluten, according to Frerichs, is rapidly dissolved in artificial gastric juice, though when boiled a somewhat longer time is needed. Raw gluten is also dissolved by dilute acid without the aid of pepsin, although, according to Cnoop Koopmans, it is not a true solution, but merely a high degree of swelling (*Quellung*) and softening. The digestion of gluten proceeds most rapidly in the presence of a small amount of acid.[1]

The results of experiments on artificial digestion with extract of rennet lead to the question of the digestibility of the various articles of food, a satisfactory answer to which would be of the highest value for practical purposes. But a closer consideration of this question shows that it is extremely difficult to place on a sound basis general conclusions as to the digestibility of the several articles of food. It has already been shown by Frerichs, and still more clearly by Lehmann, that the greater number of conclusions on this subject will not bear the test of critical examination. This is especially the case with the earlier observations, in which the digestibility of a food was judged of by the subjective sensation of comfort or discomfort following its ingestion. But in so doing the observer confounded digestibility with toleration, i.e. with those conditions which the ingested food induces in the digestive organs and which then find expression through the sensory nerves. It cannot indeed be questioned that the digestibility of a food must also affect the ease with which it is borne. On the other hand it needs no proof that the subjective sensations excited by the reception of food depend in the first place on the condition of the digestive organs for the time being. No doubt all observations bearing on the toleration of foods in various states of the system are for the physician of no less importance than considerations of its digestibility. One must not, however, fail to distinguish the two conceptions, and the ways and means whereby our knowledge may be extended in each direction are quite different in character.

By the digestibility of a food one can obviously understand nothing more or less than the sum of the resistances that it

[1] Dr. Rinse Cnoop Koopmans, *Beitrag zur Kenntniss der Verdauung der eiweissartigen Körper des Pflanzenreichs*; Moleschott's *Untersuchungen*, vol. ii.; Canstatt's *Jahresbericht*, 1857.

offers to the action of the gastric juice. That these resistances are unequal follows from the very different behaviour of the several albuminates in the experiments on artificial digestion described above, and this will be the case in a still higher degree with the more complex articles of food. So long as one seeks to arrange all the various articles of food in a fixed series in respect of their digestibility, so long will one be met by insuperable difficulties. Experiments on artificial digestion suffice indeed to show within what time a perfect solution and peptonisation of each albuminate is effected by the gastric juice. But in these experiments one cannot reproduce all the conditions existing in the living stomach; especially is it impracticable to experiment on the mixtures of the most diverse aliments which are actually taken into the stomach; besides which the solution of albuminates by the gastric juice is but a small part of the collective act of digestion.

But, further, even immediate observations on the living animal can only give approximate results as to the digestibility of foods, since we possess no exact measure applicable to the processes in question. One can at best only see what quantity of various substances are brought into a condition fit for absorption during their passage through the alimentary canal in the administration of particular foods. But in this way one proves not the digestibility but the utilisation of the food, which latter depends not only on the action of the gastric juice on the ingesta themselves, but also on many other factors, notably on the mode of the peristaltic movements. In most observations having for their object the digestibility of the several ingesta in the living stomach the points kept in view were the period within which certain substances were reduced to a uniform pulp, and how long this remained in the stomach. It is plain that by this means alone no satisfactory results could be obtained. Above all one must remember that the expulsion of the contents of the stomach through the pylorus does not indicate any definite stage of digestion, and that in this respect the chyme at the time of its passage into the duodenum may in consequence present very different characters.

All enquiries into the digestibility of particular foods are met by the objection that the same substance under differing

circumstances, among which the mode of cooking takes the first place, offers very different degrees of resistance to the action of the gastric juice. Besides the activity of the digestive organs is subject to individual and temporary variations. It thus follows that generalisations from single observations can be made only with great qualifications, and that even carefully conducted experiments should often lead to contradictory results is not to be wondered at.[1]

Numerous experiments on the digestibility of the various articles of food were made by Gosse and by Beaumont. The former possessed the power of vomiting at will, and thus of emptying out the contents of his stomach at any time. This power he turned to account in ascertaining within what time the different foods were reduced to a uniform pulp. Beaumont conducted a number of experiments on the well-known Canadian Alexis St. Martin, who in consequence of a gunshot injury long retained a gastric fistula through which he could see in what time the foods were reduced to chyme or passed onwards into the duodenum. It has been already remarked that experiments and observations of this kind cannot settle definitively the question of the digestibility of the various articles of food, and the above-named observers began by the error of experimenting on too complex mixtures of food, though Beaumont himself admitted that such mixtures behave very differently during the process of digestion to the simpler aliments. From the general conclusions to which Beaumont came it appeared that animal and farinaceous foods were found more easily digested than vegetables, which often left the stomach in an undigested state; fatty substances from this point of view appeared highly indigestible. The digestibility of foods was to a great extent dependent on their tenderness and ease of comminution; thus, for example, game was the most digestible of foods. Alcoholic drinks and condiments, with the exception of salt and vinegar, were quite needless for the process of digestion, often indeed injurious.[2]

The period required for digestion varied with the quantity and quality of the food and the condition of the stomach at the time.

A moderate meal of bread and meat was disposed of in three or

[1] Blondlot, from his observations on dogs with gastric fistulæ, came to the conclusion that the digestibility of foods depended solely on the state of the stomach at the time, and that consequently all enquiries into the subject were lost labour.

[2] According to the experience of Gosse digestion was favoured by the use of salt, mustard, and other condiments, as well as by wine, old cheese, and sugar.

three and a half hours on an average; large quantities of food caused indigestion and other disturbances.[1]

To most of Dr. Beaumont's dicta one must assent; certainly no experimental proof is required to demonstrate the material influence exerted on their digestion by the mechanical arrangement and state of aggregation of the ingesta. It is evident that tender muscular fibre must be more easily digested than sinewy tissues and fascia, or that vegetable structures composed of young and tender cellulose are sooner reduced than such as have been converted into woody fibre. Nor can one doubt that foods in a soluble or finely divided state are more digestible than others in large compact masses, since in the former cases the gastric juice has access to a larger surface. At the same time one can scarcely speak of the digestion of substances in a state of solution, since they are capable of absorption as such and need no previous preparation. Lastly, it is very probable that a copious admixture of fat and saturation of the ingesta therewith checks the action of the gastric juice.

Several observers since the time of Beaumont have materially advanced our knowledge of the digestion of single articles of food, but they have as a rule confined their attention to the mode of solution of solid substances in the gastric juice and to the conditions of absorption. Thus we know that milk is coagulated in the stomach by the action of the peptic juice, the serum being speedily absorbed. The curdled casein encloses the fat in itself, forming a tough adhesive coagulum: such at least is the case with cow's milk, the casein of human milk giving a much finer curd. As the casein is dissolved the fat globules gradually coalesce into larger fat drops. Frerichs, experimenting on a dog with a gastric fistula, could detect the milk sugar in the stomach for the first hour after feeding, but not later as a rule. It is also certain that some of the curd constantly passes into the duodenum undissolved.

Flesh on entering the stomach swells out, and if taken in the raw state exchanges its red colour for a grey-brown; it presently softens, and is finally reduced to a gruel-like mass. According to Frerichs the several elements of muscular tissue are of unequal degrees of solubility; the connective tissue is first dissolved, setting free the individual fibres, next the sarcolemma, and lastly the substance between the transverse striæ. In like manner it has been noticed that cooked meat is somewhat sooner dissolved than raw, the gastric juice penetrating with greater ease between the fasciculi and the

[1] W. Beaumont, 'Recent Experiments on the Gastric Juice,' in *The Physiology of Digestion.* Edin. 1838.

fibres; further, the width of the fibres has, according to Frerichs, some influence, the broad fibres of older animals requiring a longer time than those of young ones for their solution. The flesh of fish is considered harder of solution as a rule, since when stirred up with fluids when in a state of fine division it swells out into an almost homogeneous mass, on which the gastric juice acts but slowly.

Eggs when boiled hard present most unfavourable mechanical conditions for the action of the gastric juice. Thus Uffelmann observed in the case of a gastrotomised and feverish patient that hard-boiled white of egg was scarcely digested at all, and large pieces were passed unchanged with the fæces.[1]

Animal gelatin belongs, in the unanimous opinion of all observers, to those substances that are most easily dissolved in the stomach and soonest disappear from it. Gelatinous tissues behave in like manner if of loose structure and submitted to the gastric juice in the cooked state; the tough connective tissue rich in elastic fibre is, on the other hand, very insoluble.

As to the time which foods remain in the stomach, the observations of Beaumont cannot be accepted as of absolute value, for according to others the gastric digestion demands as a rule much more than three to five hours; certainly it is so with vegetable foods, and Frerichs as well as Bidder and Schmidt frequently found the remains of these in the stomachs of their dogs twenty-two hours after a meal. Schmidt Mülheim found in his experiments on dogs that even meat occasionally took a longer time than five to six hours.[2] The character of the food, various nervous influences, &c., may, it is clear, cause the duration of digestion to range between wide limits.

Several chemical reagents, as strong acids, metallic salts, or concentrated alcohol and the action of high temperatures, may impair or completely destroy the activity of the gastric juice. Depression of temperature retards digestion, but a cold even of zero [i.e. freezing point] does not permanently destroy the energy of this secretion.[3]

Bile in like manner arrests the action of the gastric juice, causing in the digestive fluids a precipitate by which the pepsin is mechanically thrown down, but recovers its power on the solution of the bile precipitate. The digestive process is also

[1] Uffelmann, 'Beobachtungen und Untersuchungen an einem gastrotomirten fiebernden Kranken,' *Deutsch. Arch. f. klin. Med.*, vol. xx. p. 559.

[2] A. Schmidt Mülheim, 'Untersuch. über d. Verdauung der Eiweisskörper,' *Arch. f. Anat. u. Phys.*, 1879, 'Phys. Abth.,' p. 39.

[3] The chief reason why we are in the habit of taking most of our food

retarded by an accumulation of materials, apparently in consequence of the abstraction of water by the pepsin checking the swelling and softening of the albuminates present. It is also necessary to the regular performance and course of the function that the fully elaborated products of gastric digestion should be continually removed either by absorption or by being passed on into the duodenum. Indeed Schmidt Mülheim observed that after the formation of a certain quantity of these products their removal kept pace with the process of digestion, and occasionally large volumes were discharged at once into the intestine. The experiments of Tappeiner are opposed to the notion that the greater part of the products of gastric digestion are absorbed as fast as they are produced, showing as they do that the power possessed by the stomach of absorbing watery solutions is notably less than that exhibited by the bowel.[1]

The most important functions of the stomach, the secretion of the requisite amount of active gastric juice, and the propulsion of the chyme into the duodenum, are liable to frequent disturbances. Thus Beaumont long since observed in the case of the Canadian with the gastric fistula that the natural secretion of the mucous membrane of the stomach was much diminished, or even entirely suspended, when that organ was the seat of catarrh or during general febrile states of the system. Under such circumstances food was found undigested after from 24 to 48 hours, and its putrefactive changes set up further disorders of the digestion.

Beaumont's views on the prejudicial effects of hyperæmia and anæmia of the mucous membrane of the stomach on the secretion of the gastric juice have been fully confirmed and extended by later observers. It is beyond doubt that insufficient secretion is the essential cause of most dyspeptic symptoms as they appear in the course of various disorders of the stomach. In all febrile conditions, too, the secretion of gastric juice is constantly

warm is doubtless simply because most dishes are more palatable when hot since such dishes as are not improved by warming are, as a rule, eaten cold. Still the temperature of the ingesta is not without an influence on their digestibility and toleration. Too high a temperature in the food is positively injurious, but we have daily abundant evidence that some foods are best taken hot, others best cold.

[1] H. Tappeiner, 'Ueber Resorption im Magen,' *Zeitschr. f. Biologie*, vol. xvi.

diminished, and in the presence of very high temperatures as well as of severe adynamic states it may, according to the observations of Uffelmann, be entirely arrested. In such cases instead of an active gastric juice the stomach secretes a fluid rich in mucin, and as a rule neutral or even alkaline.

It is also not impossible that the secretion of an active gastric juice in sufficient quantity may be checked by various disturbances in the region of the nervous system.

A retarded and incomplete gastric digestion must also of necessity follow when either the pepsin or the free acid is in insufficient quantity or when they are not present in the proper relative proportions. In this way the dilution of the gastric juice observed in animals as a consequence of hydræmic plethora probably acts. Since, however, very small quantities of pepsin are capable of acting on large amounts of albuminates, if only a sufficient quantity of free acid be present, it follows that a deficiency of the latter must be of far greater importance than an abnormally small secretion of pepsin. Actually it would seem that a want of pepsin is of far less frequent occurrence than a deficiency of acid, which has been demonstrated in numerous cases. Thus it was experimentally shown by Manasseïn that in animals which had been reduced by repeated bleedings to a condition of acute anæmia, and in others rendered febrile by putrid injections, a gastric juice was secreted which acted much less perfectly on albumen than the normal secretion. But infusions of the mucous membrane of the stomachs of the same animals prepared with dilute hydrochloric acid showed a high degree of digestive power, whence he concluded that in such conditions it was from a deficiency of free acid that the digestion was imperfect, the pepsin being present in due amount.[1] Observations agreeing with these have been made by other enquirers on the human subject in febrile states, whence it follows that a deficiency of acid in the gastric juice may be set down as one of the regular phenomena of fever.[2] At the same time Uffelmann is of opinion

[1] W. Manasseïn, 'Chem. Beiträge zur Fieberlehre,' *Virchow's Arch.*, vol. lv. p. 413.

[2] R. v. d. Velden, 'Zur Lehre v. d. Dyspepsie bei Typhus,' *Berl. klin. Wochenschrift*, 1877, No. 42. (A patient with gastrectasia was attacked by typhus, and during the course of the fever it was impossible to detect free acid in the gastric juice, although previously it had been in normal amount.)

that other factors are concerned in the production of febrile dyspepsia.

Leube has also advocated on good grounds the view that a want of free acid is of frequent occurrence alike in acute and chronic gastric catarrh, and is of special influence in the production of disorders of digestion. Grützner arrived experimentally at the like results, since he found that the mucous membrane of a dog that had been brought into a state of chronic inflammation by the continued administration of highly indigestible food yielded a secretion which did not always give an acid reaction, but was sometimes neutral and at others even alkaline, and always so when it contained little pepsin. While too the secretion was continuous it was not materially increased by the access of food.[1] The neutral or alkaline reaction of the gastric juice in such cases is owing to the facts that, in consequence of the inflammation, an alkaline transudation is poured out from the surface of the mucous membrane, and that the secretion of mucus is abnormally increased. Thus not only is the free acid of the gastric juice partly neutralised, but its action on the ingesta is mechanically impeded.

The consequences of a deficiency of acid are obvious. The albuminates are not dissolved, or are at least imperfectly acted on, and further putrefaction and fermentation of the ingesta are set up, which under normal conditions are checked only by the strongly acid character of the contents of the stomach. Lastly, as a result of this want of acid the stomach ceases to empty its contents duly and at the right time into the duodenum, since the increasing acidity of these during the progress of digestion is probably, as we have said already, the stimulus whereby active peristaltic movements of the stomach are excited.

Lactic fermentation is indeed, as we have already explained, to be looked on as a normal process of digestion; but it is probable that in pathological states it is carried much further than under normal conditions, especially when the food is retained an undue time in the stomach. But if the decomposition of the ingesta, which is normally counteracted by the increasing acidity and the propulsion of the

[1] P. Grützner, *Neue Untersuchungen über die Bildung u. Ausscheidung des Pepsins*, p. 79. Breslau, 1875.

chyme into the duodenum, suffers no interruption, the lactic acid is further transformed into butyric, with evolution of carbonic acid and hydrogen, precisely as happens out of the body through the action of putrefying albumen on sugar. Besides the lactic, or rather the butyric, fermentation the yeast fungus which is often present in the contents of the stomach may convert the carbohydrates into alcohol and carbonic acid, the greater part of the alcohol being oxidised into acetic acid. In some cases, again, marsh gas has been found in the stomach; Ewald noticed one in which the gases eructed from time to time by the patient burnt with a feebly luminous flame and contained a large proportion of marsh gas. The relation between the several gases and the food could not be demonstrated.[1]

These fermentive processes lead on the one hand to an abnormal evolution and accumulation of gases in the stomach, and on the other to the formation of various organic acids.

It might be imagined that these acids would compensate in some degree for an original deficiency of hydrochloric acid, and, provided that the acidity did not reach too high a point, counteract the derangements of the digestion. But it must not be forgotten that the fermentive processes generate organic acids which are not of equal value with hydrochloric, and only act when in a comparatively concentrated form. One must, therefore, agree with Leube and others who hold that in many cases the quantity of the normal acid necessary to active gastric digestion may be absent, although highly acid eructations and other symptoms show an abnormal formation of other acids in the stomach of the patient in question.

A great part in the production of derangements of digestion must be attributed to all those circumstances which hinder the

[1] While under normal conditions the gases of the stomach consist in large part of atmospheric air, analyses of two samples of those eructed by the patient who was suffering from carcinoma of the stomach, and taken at an interval of half an hour apart, gave the following composition:—

	1st	2nd
Carbonic acid (CO_2)	17·40 vols. p.c.	20·57 vols. p.c.
Hydrogen (H)	21·52 „	20·57 „
Marsh gas (CH_4)	2·71 „	10·75 „
Olefiant gas (C_2H_4)	traces	0·20 „
Oxygen (O)	11·91 „	6·52 „
Nitrogen (N)	46·44 „	41·38 „

Planer found in a dog, five hours after a meal, 25 vols. per cent. of carbonic acid, 68·68 vols. per cent. of nitrogen, and 6·12 vols. per cent. of oxygen.

A. Ewald, 'Ueber Magengährung und Bildung von Magengasen mit gelb brennender Flamme,' *Arch. f. Anat. und Phys.*, 1874, p. 217.

regular passage of the chyme into the duodenum. This is always the case when the muscular power of the stomach is unequal to the due expulsion of its contents, so that stagnation of the ingesta, and ultimately dilatation of the stomach, follow as consequences. The most effective impediment to the regular evacuation of the stomach is of course presented by those stenoses of the pylorus which can be compensated for only by a corresponding hypertrophy of the gastric muscles; in the majority of cases such adequate and lasting compensation is not attained, and consequently the dilatation of the stomach constantly assumes greater proportions.

But even when the aperture of the pylorus is in a natural state the muscular power of the stomach may be insufficient for the expulsion of its contents, as when the organ is habitually over-filled or the energy of the peristaltic movements is in any way weakened. This will occur as a consequence of morbid growths or tumours in its walls, and without doubt nutritive derangements of the muscles may bring about a condition of weakness and feeble irritability. Inflammatory processes of all kinds involving any one or more of the coats of the stomach are of the highest importance in this respect, since they induce a more or less paretic condition of the muscular fibres. In this way no doubt even acute catarrh of the stomach acts, and the same occurs in graver inflammations in a still higher degree. If in such cases the disproportion between the expulsive power of the stomach and the demands put upon it is maintained for a long time, permanent distension and dilatation of the stomach must follow.[1]

An insufficient evacuation of the contents of the stomach must act prejudicially both on digestion itself and on the subsequent utilisation of the nutriment in the intestine. To this we must add that each several reception of food retarding the compensation of the derangements and giving a further impulse to the anatomical changes is positively injurious. It is a most important circumstance to be borne in mind in all dyspeptic conditions that the several functions of the stomach are interdependent in the highest degree, so that no one can

[1] For an exhaustive treatment of this subject see *Volkm. klin. Vortr.*, No. 153; also Leube and Cohnheim in other places.

be performed without the others, to say nothing of compensatory actions. In diseases of the stomach every form of food that is not easily digested and passed out of that organ sets up new and injurious consequences, so that on this ground alone the dieting of such cases is fraught as a rule with the greatest difficulties.

Under some circumstances it is even desirable that the stomach should relieve itself of mechanically irritating or decomposing contents, and in such cases vomiting has a regulatory value. But not only abnormal and violent irritation affecting the mucous membrane, but also numerous other causes may excite a vomiting which has no such alleviating effect, on the contrary depriving the food administered of all value to the patient. In those diseases of the stomach which are attended with frequent vomiting we have often to deal with a morbidly exaggerated irritability of the sensory nerves of the mucous membrane, so that even normal stimuli excite the movements of vomiting.[1] An abnormal irritability of these nerves is a factor that must in many ways be reckoned with in the dieting of patients who suffer from symptoms of dyspepsia. According to Uffelmann febrile dyspepsia too is partly due to an exalted irritability of the mucous membrane of the stomach.

After the passage of the chyme into the intestine the acid mixture of nutriment and indigestible substances is submitted to the action of other digestive juices, and in the first place to that of the bile and the pancreatic juice.

The bile is being secreted continually, but its quantity and composition are subject to considerable oscillations; the influence of food is especially marked, the rapidity of the secretion falling off during fasting and rising rapidly during digestion. The bile seems to be most abundant after a highly albuminous diet has been indulged in for some time, while it falls off under an exclusively fat diet, just as in fasting.

When the bile is not absorbed as usual in the bowel, but flows away by a biliary fistula, a certain effect on the secretion makes itself seen. In the first few days after the establishment of a gastric fistula in an animal one observes a regular falling off in the secretion, which, however, at once rises again if the bile is introduced into the bowel. Whether it is that we have to deal with a sort of biliary circulation,

[1] See Cohnheim, l.c.

or that the glands are stimulated by it to an increased activity in a reflex manner, we cannot as yet certainly decide.

The secretion of the bile is also to a certain degree dependent on the circulation of blood in the liver: thus it is diminished by copious bleeding or by mechanical obstruction of the branches of the portal vein, and stimulation of the spinal cord or the splanchnic nerves acts in like manner through the narrowing of the visceral arteries induced thereby. The rapidity of the secretion increases with the blood-supply to the liver so long as the pressure in the portal vein does not exceed a certain limit; otherwise the over-filled vessels exert compression on the smaller bile-ducts and liver-cells. These considerations serve to show that derangements of the circulation in the liver, of however frequent occurrence they may be, are not without an influence on the biliary secretion, although one must avoid over-estimating the gravity of these derangements.

We have very little positive knowledge as to the secretion of bile in pathological conditions, though it is evident that extensive alterations in the parenchyma of the liver cannot be without influence on its secreting powers. As regards the effect of febrile processes on the secretion, we have the observation of Uffelmann that in a patient with a biliary fistula the flow was suspended during the attacks of fever.[1]

The function of the bile in the digestive processes has at different times been variously estimated. In the present state of our knowledge we believe that it exerts no digestive action on albuminates, entering into that process only so far as by mixing with the acid chyme from the stomach it suspends the further action of the pepsin. This interruption to the peptic digestion occurs although the chyme retains its acidity; indeed the idea of a neutralisation of the acids of the stomach by the feebly alkaline or neutral bile is inadmissible. According to Brücke and Hammarsten it is rather a precipitation of the pepsin, since, as we have already stated, bile produces in the acid fluids of the stomach a precipitate with which the pepsin is thrown down. Further, the presence of the bile

[1] Uffelmann, 'Die Störung des Verdauungsprocesses in der Ruhr,' *Deutsch. Arch. f. klin. Med.*, vol. xiv. p. 228.

arrests the softening of albuminates in the acids of the gastric juice.[1]

To the question how far the bile by the above-named action on the gastric chyme contributes to the digestion of albuminates different answers have been given. Hammarsten sees in it a decided advantage, since the resinous character of the precipitate thrown down by the bile causes it to adhere to the intestinal wall and the too rapid passage of the albuminates onward is prevented. According to the views of Kühne the chief advantage derived from this interruption is that the active gastric juice has the power of impeding the pancreatic digestion.[2] On the other hand the experiments of Voit prove that the utilisation of albuminous food proceeds as well after the establishment of biliary fistulæ as before the operation. The digestion too of gelatin and of the carbohydrates is not impaired by the absence of bile from the bowel. The animal is capable of assimilating the same amount of these bodies, and excretes a like quantity of fæces as before.[3]

The presence of bile in the intestine is of the greatest importance in the absorption of fat; so that as a consequence of its absence a large proportion of the fatty matters of the food passes away undigested in the fæces. Thus Voit in his experiments on dogs with gastric fistulæ found that of a daily consumption of 100 to 150 grammes of fat mixed with other food only 39·7 per cent. was absorbed, and 60·3 per cent. discharged with the fæces. Larger quantities of fat could not be tolerated at all, but soon gave rise to loud gurgling in the bowels and to diarrhœa with an abominable odour. The fæces exhibited the pale, clayey character seen in cases of jaundice in man, whereas on a pure meat diet they were of a natural dark colour, thus showing that the whitish colour of icteric stools is due rather to the presence of a large quantity of fat than to the absence of the biliary pigment, as commonly supposed.

[1] For the conditions under which bile throws down a precipitate acid gastric juice containing albuminates in solution see Maly, *Chemie der Verdauungssäfte*, p. 180.

[2] W. Kühne, 'Ueber das Verhalten verschied. org. u. sog. ungeformter Fermente,' *Verhandl. d. naturhist. Vereins zu Heidelberg*, New Series, i. 1876.

[3] C. Voit, 'Ueber die Bedeutung d. Galle für d. Aufnahme der Nahrungsstoffe im Darmkanal,' *Naturforscherversammlung zu Salzburg*, 1881.

Voit also observed that the fæces passed by dogs with biliary fistulæ after the administration of fat contained mostly unaltered neutral fats, a small proportion only having been converted into fatty acids.

The fact that when the access of bile to the bowel is prevented only small quantities of fat are absorbed sufficiently explains several phenomena observed in dogs with biliary fistulæ, such as the ravenous appetite, great emaciation, &c. These symptoms did not appear when the fat in their food was replaced by carbohydrates; the animals then long maintained their condition; but when fed on flesh and fat, the most appropriate diet under normal conditions, the greater part of the non-nitrogenous principles so important to the economy was practically wanting, and the animals required enormous quantities of meat, like those fed on it alone.

The action of the bile in aiding the passage of the fats into the lacteals is mainly attributable to its power of emulsifying them; it is believed that the fatty acids set free from the neutral fats through the splitting up of these by the pancreatic juice are saponified by the bile, thus producing a fine emulsion. The function of the fatty acids in the emulsion of fats has been exhaustively investigated of late by Joh. Gad.[1] On the other hand Th. Cash infers, from the fact that the subdivision of the fat into minute drops, seen in the highest perfection in the lacteals, is not visible in the intestine itself during the digestion of fat, that one must assume the absorption of fats in the free state and their conversion into an emulsion only after their entrance into the absorbents.[2] The great importance, then, of the bile in the absorption of fat lies, in the first place, in the power of moistening as it were the fat. Oil passes through a membrane moistened with water only under high pressure, whereas it passes easily and without any pressure through one soaked in bile.

Since the bile in the intervals of digestion is stored up in a

[1] Joh. Gad, 'Zur Lehre von d. Fettresorption,' *Arch. f. Anat. u. Phys.*, 'Phys. Abth.,' year 1878, p. 181; compare also E. Brücke, 'Ueber die phys. Bedeutung der theilweisen Zerlegung der Fette im Dünndarme,' *Sitzungsber. d. Wien. Akad.*, 1870, vol. lxi. sect. ii. p. 363.

[2] Th. Cash, 'Ueber den Antheil des Magens und des Pankreas an d. Verdauung des Fettes,' *Arch. f. Anat. u. Phys.*, 'Phys. Abth.,' year 1880, p. 323.

reservoir—the gall bladder—so that during digestion an abundant supply is ready for saturating the chyme, the question whether an impervious condition of the cystic duct involves serious interference with the digestion of fats must be answered in the affirmative, an admixture of bile at the requisite moment being impossible.

Of the other actions of the bile we need only mention that it acts as a stimulant to the peristaltic movements of the intestine. Certain antiseptic effects on the contents of the bowel have also been ascribed to it, since it has been remarked that active putrefactive processes take place in the bowels of dogs with biliary fistulæ and of icteric patients. But, according to the experience of Voit, these abnormal putrefactive changes do not continue if fat is withheld, although the bile is still excluded from the bowel.

The pancreatic juice or intestinal saliva is poured into the gut at the same point as the bile, the ductus choledicus and the pancreatic duct discharging their secretions most often by a common aperture, and only more rarely has each a separate opening of its own in the duodenum. Not unfrequently smaller accessory ducts are seen communicating with the larger, but sometimes possessing separate mouths.[1]

Under normal conditions the secretion of the pancreatic juice does not appear to be continuous; it is dependent on the reception of nourishment, reaching its maximum within the first three hours of digestion, but ceasing only with its completion. The connection between feeding and the secretion of the pancreas was explained by Schiff as a 'charging' of the gland by the absorbed nutriment—i.e. with the materials for the elaboration of the pancreatic juice. But it would appear from several facts that the pancreas is stimulated to action by the ingestion of food rather in a reflex manner.

When at rest the pancreas is pale and flabby, but during digestion it becomes of a bright red colour and turgescent; the capillaries are distended and clear red blood flows from its veins. One might conceive that it was the active blood stream within the gland, induced solely by reflex stimulation, which provided the secretion, and the observation that as a rule the solid constituents of the pancreatic

[1] See Friedreich, 'Pankreaskrankheiten,' in Von Ziemssen's *Handb. d. spec. Pathol.*, vol. viii. p. 2.

juice are lessened as the secretion itself proceeds more rapidly would appear in harmony with this supposition. Several observations, however, seem to indicate that during the reception of food there is not merely an augmented circulation of blood in the gland, but that there is a reflex stimulation of the secretory nerves. Since, however, division of the nerves leading to the pancreas does not arrest its secretion, one is driven to the conclusion that there is an independent nervous apparatus within the gland, on which the nerves entering it act, partly as paths of stimulation or acceleration, and partly of inhibition.[1]

The pancreatic juice exerts a digestive action not only on albuminates but also on fats and carbohydrates, and this power depends on the presence of three distinct ferments.

The secretion of the healthy pancreas is a watery mucous fluid with an alkaline reaction, yielding in the cold a gelatinous coagulum and containing a large proportion (6 to 10 per cent.) of solid matters. During the several stages of digestion its concentration varies much, the variation being greatly but not exclusively dependent on the rapidity with which it is secreted.

Normal pancreatic juice can be obtained only by means of temporary fistulæ, for when a permanent fistula is established the gland secretes continuously a thin inert fluid containing only 1 to 2 per cent. of solids, and shows in its other histological characters persistent alterations analogous to those which occur in the healthy gland at certain stages of digestion indicative of exhaustion of the secreting cells.[2]

The albumen-digesting ferment of the pancreatic juice, trypsin, is not present as such in the living gland, but is formed only in the separation of the secretion from a previously existing and transitional stage, the so-called zymogen. The action of this ferment is most energetic, being indeed best exerted in a weakly alkaline fluid, but nevertheless occurring in neutral or weakly acid ones. The products of the pancreatic digestion of albuminates are peptones agreeing in all essential points with the pepsin peptones. Under the long-continued action of the pancreatic juice some of these peptones undergo further changes, yielding among other products of splitting up large quantities of leucin and tyrosin.

The most rapid effects of the pancreatic juice are seen in its

[1] Compare Heidenhain, *Physiol. der Absonderungsvorgänge u.s.w.*

[2] See Heidenhain, l.c.

action on starch; indeed at 37° to 40° C. a considerable bulk of starch is almost instantly dissolved into starch paste and sugar, formed at the same time. In other respects the action of the amylolytic ferment of the pancreas resembles that of the saliva. The diastatic power of the pancreatic secretion is not impaired by the admixture of gastric juice or bile.

A third ferment gives the pancreatic juice the power of splitting up the neutral fats into glycerin and their respective acids. This action, although it is presumably exerted on a small proportion only of the fats ingested, is not without influence on their digestion. The splitting up of the fatty acids contributes materially to the formation of a fine and permanent emulsion when liquid fats are mixed with pancreatic juice. On the other hand numerous observations show that large quantities of fat can be absorbed without the presence of pancreatic juice in the bowel, if only the bile has free access, whereas if that be excluded the absorption of fat is in the highest degree impaired, notwithstanding the unimpeded presence of the pancreatic secretion. Bernard's view, therefore, that the pancreatic juice is the sole agent in the digestion of fat is incorrect, and only when associated with the bile has its action any value.

The pancreas and its juice are extremely prone to putrefaction, so that digestive mixtures, after standing only a few hours at temperatures of from 30° to 40° C., begin to show signs of putrescence and the development of bacteria. The putrefactive ferments lead in a somewhat longer time to the formation in the food of products of decomposition which do not appear in pure pancreatic digestion; CO_2, H_2, CH_4, H_2S, and bodies marked by a foul odour, as phenol and indol, are formed. But in the intestine there is no such thing as pure pancreatic digestion; and many other ferments are present by means of which not only CO_2 and H_2, but in the large intestine also CH_4 and traces of H_2S, are evolved.[1]

The pancreas appears to be a very sensitive organ, prone to suffer from derangements of its functions on many occasions, and we may well believe that impediments to the flow of its secretion into the bowel not unfrequently occur together with

[1] Nencki, *Ueber d. Zersetzung d. Gelatine u. d. Eiweisses bei der Fäulniss*

and under the same conditions as those which affect the discharge of the bile, although graver diseases of this organ are rare. Whether slight anomalies, quantitative or qualitative, in the function of the pancreas lead to any consequences whatever in respect of digestion is not known; but even in those cases where intestinal digestion must be conducted entirely without the co-operation of the pancreatic juice no constantly occurring disorders of digestion or nutrition have been observed. We meet, however, in medical literature with cases where rapid emaciation has followed diseases of the pancreas, and an explanation of which could be found only in the suspension of its functions. But against such observations we must set others in which the general nutrition has not suffered, in spite of grave disease of the gland, and the results of experiment agree rather with these latter. We must therefore conclude that without the aid of the pancreas the other factors in the digestive process are able to effect the absorption of a quantity of nutriment sufficient for the maintenance of the organism in a fair state of nutrition.

The question now remains to be solved how far the absence of the pancreatic juice interferes with the absorption of fat, since the passage of large quantities of fat with the stools has been often, though by no means constantly, noticed in diseases of the pancreas. So far as we know at present the pancreatic juice alone, without the presence of the bile, can effect the absorption of but a fraction of the ingested fat; nevertheless it is conceivable that the action of bile in the assimilation of fat may be but imperfectly performed without the co-operation of the pancreatic juice. Perhaps the true state of the case may be that while a moderate admixture of fat with the food may be absorbed by means of the bile alone, larger quantities cannot be without the aid of the pancreatic juice at the same time.

The remaining digestive juices which are poured into the bowel include the secretions of two distinct sets of glands, those of Brunner, confined to the upper part of the small intestine, and those of Lieberkühn, deeply embedded in the mucous

mit Pankreas, Bern, 1876; W. Kühne, *Ber. d. deutsch. chem. Gesellsch.*, 1875, vol. viii.; Hüfner, *Journ. f. prakt. Chem.*, New Series, vol. li.; E. Baumann, *Zeitschr. f. phys. Chem.*, i. 1877; cf. also Hoppe Seyler and Maly and others.

membrane and closely packed throughout the whole extent of the small and large intestines. Besides these there is no doubt but that the superficial epithelium cells of the mucous membrane share in the secretory process by the formation of the intestinal mucus.

Brunner's glands exhibit, both in their structure and from a physiological point of view, a close resemblance to the pyloric glands of the stomach. According to Budge and Krolow the watery product of these glands is capable of converting starch into dextrin and sugar and of digesting fibrin in acid solutions.[1] Grützner considers the ferment yielded by Brunner's glands to be pepsin, but he could not demonstrate any diastatic effects produced by the secretion of these glands.[2] As to how far and with what consequence these glands share in diseases of the intestinal mucous membrane nothing is known.

Lieberkühn's glands are small depressions lined with cylindrical gland cells. According to Heidenhain the secreting cells of the glands in the small and large intestines show differences which seem to indicate that the glands in the two regions fulfil distinct functions. In the follicles of the glands of the large intestine we find between the cylindrical epithelium numerous mucous cells, which during the activity of the bowel disappear with a discharge of mucus, so that in this section of the intestines Lieberkühn's glands may be regarded as simple mucous glands. In those in the small intestine, on the other hand, there are but solitary mucous cells between the cylindrical ones, and the secretion is a thin watery fluid, so that these may be looked on in the light of true glands secreting a proper succus entericus.[3]

The secretion of Lieberkühn's glands constitutes probably the greater part of the so-called succus entericus, as to the quantity and properties of which the views of different observers vary considerably. In passive states only small quantities of secretion are yielded, but during digestion and under irritation of the mucous membrane probably no inconsiderable amount is poured out. Little is known as to the dependence of the secretion on the nervous system, but the statements of Budge, who found that after extirpation of the cœliac and mesenteric

[1] Krolow, *Berl. klin. Wochenschr.*, 1870, No. 1.

[2] Grützner, *Arch. f. d. ges. Phys.*, Bd. xii., 1876. See also the Handbooks frequently quoted above.

[3] Gregor Klose, *Beitr. zur Kenntniss der tubulösen Darmdrüsen*, Breslau, 1880. Cf. Heidenhain, l.c.

plexuses the secretion was augmented, deserve notice.[1] Moreau too observed the collection of a large quantity of secretion in a ligatured loop of the bowel when the nerves leading to it were divided,[2] a result which in the opinion of Cohnheim must be regarded in the light of a paralytic hypersecretion of the succus entericus.

The pure juice, best obtained by means of Thiry's intestinal fistulæ, is a clear yellow fluid with a strongly alkaline reaction, which according to the experiments of Thiry and Leube is capable of dissolving raw fibrin and of converting cane into grape sugar; on starch, however, it has no recognisable action.[3] Other observers who experimented with extracts of the intestinal mucous membrane ascribe to it a diastatic action, and Busch in his investigations with fistulæ arrived at a like result.[4] Schiff, again, attributed to the succus entericus a complex digestive power extending to all kinds of foods, but his views are in opposition to the experience of all other observers, who grant it only a subordinate rôle in the digestive processes.

We must not, however, deny that a certain portion of the food may be reduced to the fluid state in the lower half of the small intestine. This may be effected partly by the continued action of those digestive ferments which have accompanied the contents of the bowel in their passage from the duodenum to the deeper-lying sections of the intestine, and partly of the above-mentioned putrefactive ferments, the vehicles of which reach the intestine from without. These processes as a rule give rise in different regions of the bowel to different products of decomposition, so that one may well believe that several active ferments are formed at the same time. In the large intestine the digestive processes proper gradually cease, and putrefactive changes alone continue, so that as absorption of the fluids proceeds the contents of the bowel assume more and more a fæcal character the further they pass downwards.

The gases of the intestine, setting aside a certain proportion of

[1] Budge, *Verh. d. k.k. Leopold.-Carol. Akad. d. Naturforscher*, vol. xix. p. 258, 1860, quoted by Heidenhain, l.c.

[2] A. Moreau, *Bull. d. l'Acad. de Méd.*, xxxv. 1870.

[3] Leube, *Med. Centralblatt*, 1868, p. 289.

[4] Busch, *Virch. Arch.* xiv. p. 140.

atmospheric air, are formed in the bowel in consequence of fermentative and putrefactive processes, and show under different circumstances great diversity in respect of quantity and composition. The fact that the character of the food has a great influence in these respects is not without importance. Thus Ruge found with different foods the intestinal gases to have the following composition :—

Food	Milk		Meat			Peas or Beans		
	1	2	1	2	3	1	2	3
CO_2	16·8	9·9	13·6	12·4	8·4	34·0	38·4	21·0
H_2	43·3	54·2	3·0	2·1	0·7	2·3	1·5	4·0
CH_4	0·9	—	37·4	27·5	26·4	44·5	49·3	55·9
N_2	38·3	36·7	45·9	57·8	64·4	19·1	10·6	18·9[1]

The fæces invariably contain mucin and broken-down epithelium, also residual and decomposition products of the digestive juices—viz. bile, insoluble salts, and lime soaps—soluble acids, as acetic, butyric, and caproic, as well as isobutyric ; and of odorous substances, indol, phenol, and skatol. The refuse of the foods found in the fæces varies according to the quantity and quality of the food taken ; thus in a diet mainly animal, besides a small quantity of fat, only the indigestible substances, as horny matters, are evacuated with the excrement, but when large quantities of vegetable food are consumed the assimilation is far less complete.

The peristaltic movements of the bowel are a necessary condition for the regular performance of intestinal digestion, since by them are effected the intimate mixture and onward propulsion of the contents of the canal, and they have a considerable share in promoting absorption of the dissolved materials. The peristaltic movements are far more active and brisk in the small than in the large intestine. In the latter they occur only periodically, and do not as a rule begin until some hours after a meal.

Under physiological conditions the movements of the bowel are subject to various influences, of which the character and in a less degree the temperature of the food are the most prominent. The influence of the ingesta on peristalsis is a matter of daily experience, and we are thus in a position to act with success in this direction.

Under normal conditions these movements are no doubt of

[1] Ruge, *Sitzungsber. d. Wiener Akad. d. Wissensch.*, vol. xliv., quoted by Hoppe Seyler, *Phys. Chemie*, ii. p. 330.

a reflex character, the stimulation of the sensory nerves of the mucous membrane by the contents of the bowel being transmitted to the motor apparatus. Indeed it would seem to be through the ganglionic plexuses of Auerbach, seated in the intestinal walls themselves, that the stimulus is transmitted. The progress or conduction of the movements from one stimulated point in the canal to further tracts is perhaps to be explained by assuming nervous anastomoses of the ganglionic cells, one with another, for in this way the stimulation of such cells is conducted to others elsewhere.[1]

The activity of the motor apparatus in the intestinal walls is not wholly dependent on irritation of the sensory nerves of the mucous membrane, for there are other influences that either co-operate with these or are capable of directly stimulating the motor apparatus. It has been shown experimentally that the quantity and quality of the blood circulating in the vessels of the bowel has a great influence on the peristaltic movements; want of oxygen and accumulation of carbonic acid in the blood excites the contractions of the gut, and the presence of oxygen retards them. Besides these there are certain nervous influences affecting peristalsis conveyed to the ganglionic plexuses found in the intestinal wall, partly by the path of the vagus nerve and partly by sympathetic fibres from remote central organs. From the evidence at present obtained we may conclude that the nerves we have named convey both motor impulses and inhibitive influences, so that the movements of the intestine are comparable to those of the heart, since the activity of the excited motor ganglia in the substance of its walls is regulated by accelerating and inhibitive nerves.

Irritation of the peripheral terminations of the vagus in the neck, as Budge first observed, excites movements of both the large and the small intestine, and the fact has been confirmed by others. The same observers have also found that similar movements are excited by direct stimulation of the medulla oblongata, the cerebellum, and the spinal cord. On the question whether irritation of the splanchnic nerves causes movements of the bowel authorities are divided in their opinions.

Nevertheless it is most probable that these movements of the

[1] Funke, *Lehrbuch d. Physiol. von Grünhagen*, vol. ii. 1, p. 725.

intestinal muscles are always induced through the ganglia, these being first brought into a state of excitement and the motor acts following as a secondary effect. In this way it is intelligible how the consequences of irritation are subject to certain variations. The nerves in question are not to be regarded as motor in the proper sense, but as exciting in the same sense as the accelerating nerves of the heart.

Just as the excito-motor ganglia of the heart are in connection with both accelerative and inhibitive nerve-fibres, so has it been proved of the intestine that inhibitive influences can be exerted on its movements. Pflüger has shown that irritation of the lower section of the spinal cord and of the splanchnic nerves will suspend the movements of the bowel. He moreover denies that irritation of the splanchnic exerts a stimulating action of the movements of the intestine under any circumstances, as Longet, Ludwig and Kupffer, O. Nasse, S. Mayer, and Von Basch had asserted. The motor effects of irritation of the splanchnic are, however, evident enough in dead animals, whence O. Nasse inferred that the splanchnic nerve contains both inhibitive and exciting fibres, and that during life the action of the former predominates.[1]

S. Mayer and Von Basch think that the inhibitive effects on the movements of the bowels produced by irritation of the splanchnic nerves are not to be explained by assuming the existence of special fibres, as Pflüger does, but are consequent on the power possessed by that nerve of causing constriction of the blood-vessels.

One of the most important functions of the intestinal canal is doubtless the absorption of the nutritive materials elaborated by the several digestive juices into the blood-vessels and lacteals, for which the mucous membrane appears by its anatomical construction to be peculiarly adapted. Unfortunately it has not yet been possible to ascertain precisely the physical and chemical forces concerned in absorption. The attempt to explain the entrance of nutriment into the general mass of the fluids of the body by the phenomena of osmosis and diffusion must be regarded as impracticable. We do not deny that diffusion occurs in the bowel, but it cannot be the essential

[1] Pflüger, *Ueber d. Hemmungsnervensystem f. d. perist. Bewegungen der Gedärme*, Berlin, 1857; Ludwig and Kupffer, *Sitzungsber. d. Wiener Akad.*, vol. xxv. p. 580; S. Mayer and Von Basch, *Sitzungsber. d. Wien. Akad.*, sect. ii. vol. lxii. 1870; O. Nasse, *Beitr. z. Phys. d. Darmbewegungen*, Leipzig, 1866 the quotations partly from S. Mayer in Hermann's *Physiologie*, vol. v. part ii No. 1. Compare also Funke's *Lehrbuch der Physiol. von Grünhagen*.

force engaged in absorption. The filtration theory, which assumes that the nutrient matters are forced through the pores of the mucous membrane by a positive pressure exerted within the intestinal canal, seems less opposed to ascertained conditions.

The effect of positive pressure exerted by the muscular contractions on the contents of the bowel would be aided by the peculiar structure of the villi. Brücke thus supposes that the muscular fibres present in the villi contract periodically, forcing the contents of the chyle canals into the deeper-seated lacteals. When these muscular fibres again relax the villus is rapidly distended by the tension of the blood in the capillaries, so that a negative pressure is generated within them and absorption of the fluids naturally follows.

But serious objections have been urged against the filtration theory, especially by Hoppe Seyler. He is justly of opinion that a reference of the whole process of absorption to mechanical conditions is untenable, and that the absorption of nutritive matters should rather be regarded as a function of the living protoplasm in the epithelium cells of the mucous membrane. All substances, the soluble as well as the insoluble, must first pass through the epithelial layer of the mucous membrane before they can enter the blood or chyle vessels. But the way in which the former path is pursued does not correspond to any simple physical process, but suggests an active interference on the part of the epithelium. Only from the lymph spaces can the dissolved matters find their way into the blood-vessels, their absorption being favoured by the rapid movement of the blood.[1]

The several functions of the intestines are liable to frequent derangements, of more or less importance as regards nutrition. But while in diseases of the stomach anomalies in the secretion of the gastric juice play a leading part one is unable to ascribe any very great importance to the succus entericus even in pathological conditions. At least it is not known that the secretion of the intestinal mucous membrane is much reduced under any circumstances, and even should this occur it is not easy to see what further consequences would accrue than a premature inspissation of the contents of the bowel and retarding

[1] Hoppe Seyler, *Phys. Chem.* part ii. pp. 348 et seq.

of their passage onwards. Again, one can scarcely ascribe to a deficiency of the same secretion the fermentative and putrefactive processes with copious evolution of gases, since even when freely discharged, it does not check the operation of the ferments which induce these processes.

The question under what circumstances an excessive secretion from the intestinal mucous membrane takes place, and what ill effects follow the pouring out of large quantities of fluid into the bowel, is not yet decided definitely and for all cases. Without doubt in inflammatory states of the walls of the intestine, and especially in ulceration with shedding of the epithelium, transudation occurs from the blood-vessels into the bowel; but, on the other hand, the most copious discharges of fluid—such, for example, as is seen in cholera—appear to depend not on transudation, but on excessive secretion of the mucous membrane (Cohnheim).[1] Such a state of things is doubtless of the gravest import to the organism, but alterations in the character of the succus entericus and resulting derangement of the digestive process have no material share therein.

The influence of functional disturbances consequent on diseases of the bowel is to be sought for in anomalies of the peristaltic movements rather than in morbid changes in the secretion, and this is easily conceived when one considers the extreme importance attaching to these movements in the processes of digestion and absorption. Not that every deviation of peristalsis from the normal exerts an appreciably injurious effect on nutrition, but under certain circumstances the digestion and assimilation of nutriment may in this way be seriously interfered with.

An exaggeration and acceleration of the peristaltic movements takes place very frequently and under very different conditions, and always with the result of propelling the contents of the bowel onwards with undue rapidity.

Under normal conditions the contents of the large intestine are propelled but slowly, and are gradually inspissated by the absorption

[[1] I must demur to this statement, since in cholera all *other* secretions, salivary, biliary, and renal, are suspended, and it seems highly improbable that the intestinal alone should be increased. The fluid, too, which is discharged from the intestine is highly albuminous, and contains fibrine and the salts of the blood, resembling rather a transudation than an augmented secretion of the intestinal glands.—TRANSLATOR.]

of the fluid constituents. An acceleration of their passage onwards, in consequence of stronger peristalsis of the large intestine, leads to the evacuation of liquid masses, known as diarrhœa. The quantity of nutritious matters contained in the liquid stools will be in proportion to the extent of intestine in which the excessive contractions occur. Accelerated movements of the small intestine do not always induce diarrhœa, but the absorption of nutriment is impaired if the chyme is passed on too speedily into the colon.

Copious watery evacuations also occur in those cases in which peristalsis is not increased, but where there are certain changes in the epithelium or blood-vessels, induced, for example, by amyloid degeneration, and in which a transudation from the blood-vessels into the intestinal canal may be actually shown to take place. Such diarrhœas naturally are not long in inflicting serious injury on the nutrition of the body generally, such as does not follow simple acceleration of the intestinal movements.

The intensification of the peristaltic movements depends in many cases on an abnormal excitement of the sensory nerves of the intestinal mucous membrane, produced by mechanically or chemically irritating food, by decomposition of the contents of the bowel, by hard fæcal masses, and similar means. In other cases again it would seem that we have rather to deal with an abnormal irritability of the said nerve-endings, so that ordinary stimuli set up peristaltic movements of unusual activity: thus we can explain the diarrhœa so frequently accompanying catarrh and inflammation as well as ulceration of the bowel. Disorders of the circulation act in the same way, so that stasis of the blood in the mesenteric vessels, œdema of the intestinal walls, &c., may impair absorption even when the movements of the bowel are quite normal.

In many infectious diseases we frequently observe diarrhœal evacuations unattended by any constant or definable lesions of the mucous membrane. It is therefore a question whether we have in such cases to deal with an abnormal irritability of the sensory nerves, or whether nervous influences are brought to bear on the secretion in other ways.

It is at present impossible to determine the nerve-paths through which emotional impressions influence peristalsis; no more can we explain how it is that chills and exposure to wet induce diarrhœa.

Energetic movements of the bowel, if peristaltic, hasten the propulsion of its contents, but if they take the form of tonic

contraction with persistent narrowing of the canal other results will follow. Such abnormal contractions of the muscular fibres, which are seen in their extreme form in lead poisoning, necessarily retard the progress of the contents of the intestine and lead to constipation.

Diminished energy of the peristaltic movements may be owing to weakness or to a paresis of the intestinal muscles. Thus the paralysis of the bowel which supervenes on inflammation of its peritoneal coverings must doubtless be regarded as a paresis of the muscles. But disorders of nutrition may also act in like manner. In many cases the source of the weakness of the intestinal movements is to be sought rather in abnormal innervation, although one may not be in a position clearly to define the processes involved. One only is easily recognised—viz. that diminished irritability of the sensory nerves of the mucous membrane of the bowel must lead to impairment of peristalsis, such as, for example, results from the prolonged use of powerful irritants to the bowel.

Just as spasmodic contraction of the intestinal muscles leads to a tardy and insufficient propulsion of the contents of the canal, so does mere weakness of the peristaltic movements, with, however, this important difference, that a sluggish or paretic bowel becomes distended by its stagnant contents and its powers of absorption proportionately reduced. Thus a paralysed portion of the intestine may be so enormously dilated by its contents, and even more by collections of gases, that they are neither moved on nor absorbed any longer.

Enfeeblement of its movements may affect the bowel in its entire length or in single tracts only. We thus see how intense meteorism and copious diarrhœa may coexist in the same individual at the same time, that is, when peristalsis is exaggerated in the lower but diminished in the higher regions of the canal.

Of much more frequent occurrence than the paresis here described are lesser degrees of enfeeblement of the muscular movements, which, if involving the small intestine, lead to protracted digestion, with all sorts of subjective discomforts, and of course to imperfect assimilation of nutriment: lessened peristalsis of the large intestine induces a sluggishness or arrest of the evacuations.

UTILISATION OF NUTRIMENT.

Since the several articles of human food contain very different proportions of digestible and indigestible substances, and moreover offer very unequal degrees of resistance to the action of the digestive secretions, the total mass of residual matter evacuated with the stools will vary much according to the kind of food. But, besides this the mechanical and chemical characters of the ingesta greatly influence the process of absorption, and still more the peristaltic movements, and the more rapidly these propel the ingesta on to the lower portion of the intestinal canal the less complete will be their solution and absorption.

Since we do not know *à priori* how much of the nutriment contained in any article of diet will be actually absorbed, it is clear that the real nutritive value of a food can be estimated neither by the relative proportions of nitrogen and carbon nor even by that of the albumen, fat, and carbohydrates, but only by means of careful experiments as to the extent to which the aliments are appropriated by the organism. At the same time it is self-evident that the absorptive power of the intestine has limits, the overstepping of which reduces proportionately the value of the nutriment administered. To ascertain this limit in the case of each description of food is the more necessary, since the overburdening of the digestive canal with materials which it cannot perfectly elaborate is in the highest degree hurtful.

Bischoff and Voit, in the course of their investigations on nutrition, have collected numerous observations on the absorption of nutriment in the digestive canal of the carnivora.[1]

[1] From observations made on the carnivora it appears that flesh and fat, and also sugar and starch are, even when ingested in large quantities, very well appropriated by the dog, whereas with a diet of black bread copious stools are passed. E. Bischoff, in the course of his enquiries into the nutrition of a dog fed on black bread only to the amount of 800 grammes per day, recovered from the fæces 14 per cent. of the total dry solids ingested and 17 per cent. of the nitrogen therein contained, and this proportion was not altered by the addition of a little flesh and meat extract to the bread.

The fæces passed by the dog on the black bread diet were in a state of active fermentation and of an intensely acid reaction, due chiefly to the pre-

But it is far more difficult to obtain trustworthy and available information as to the utilisation of various foods in the case of man. With so highly complex a diet as he is accustomed to indulge in it is clearly impossible to draw any conclusions as to the nutritive value of the single components, even if one control the collective intakes and outputs. It is therefore necessary to test directly and apart from others each single article of food, a course beset with many difficulties.

In the first place it is impossible for a man long to maintain a state of health on a single article of food, since in none are the necessary aliments present in the requisite proportions. Besides it is extremely hard for man to deny himself a certain variety in his diet, so that when the use of one and the same food is persevered in day after day the monotony begets not only a repugnance and loathing, but an appreciable derangement of the digestive organs.

Besides, when we have brought together a number of observations on the utilisation of the various articles of food in the human digestive canal we must bear in mind that the behaviour of the elaborate mixtures of various foods commonly used may be very different from that of their several components, and that the form and cooking of the food are of no small influence. Finally, we must not forget that idiosyncrasy and habit, as well as the external circumstances under which the individual is placed for the time being, play an important part in the digestion and assimilation of food.

As regards the utilisation of the ingesta we are met at once by the marked difference which exists between animal and vegetable foods, since the latter are far less completely assimilated than the former by the human digestive organs; only the seeds of certain cereals constitute, after appropriate preparation and cooking, an exception to this rule. This behaviour of vegetable food in the human alimentary canal need not surprise us when we reflect how large a proportion of the ingesta even of herbivora pass unchanged with the fæces, although

sence of butyric acid. No doubt this acidity of the bread chyme was one of the causes of the active peristalsis, rapid propulsion of the contents of the bowel, and the consequent imperfect utilisation of the black bread (E. Bischoff, 'Versuchen über d. Ernährung mit Brod,' *Zeitschr. f. Biol.*, vol. v.).

their digestive apparatus appears to be much better adapted than ours for such a diet.

From a comparison of the utilisation of animal and vegetable foods Fr. Hofmann obtained the following values, expressing in percentages the proportion of the several aliments digested and undigested :—

Weight of Food	Vegetable		Animal	
	Digested	Undigested	Digested	Undigested
Of 100 parts of solids . .	75·5	24·5	89·9	13·1
,, 100 ,, ,, albumen .	46·6	53·4	81·2	18·8
,, 100 ,, ,, fats or carbohydrates . . .	90·3	9·7	96·9	3·1 [1]

The remarkable waste of nutriment consequent on the copious evacuations accompanying the ingestion of certain vegetable foods is due in but a slight degree to defective assimilation of starch; for very large quantities of starch can be entirely absorbed by the human digestive apparatus, provided the foods in which it is contained be in other respects favourably constituted for the action of the digestive juices. Thus, for example, with wheaten bread, rice, macaroni, &c., the carbohydrates are utilised to within 0·8 or 1·6 per cent., whereas of black bread, potatoes, and the like, 8 to 18 per cent. of the carbohydrates are passed with the fæces. It has been already shown that when indigestible vegetable foods, such as these, are administered to carnivora acid fermentation is set up, exciting the bowel to active peristalsis and speedy expulsion of its contents, and a like result follows their use by man.

In the case of many ill-digested vegetable foods their imperfect utilisation is owing to the fact that the nutritive matters are enclosed in cell-membranes which are at best incompletely and slowly dissolved, and, if lignified, not at all. And since the contents of the human intestine are propelled onwards with some rapidity there is not time for their saturation by the digestive fluids. Woody tissue too—such, for example, as is contained in the bran of black and brown bread—induces active peristalsis by mechanical irritation of the mucous membrane of

[1] Fr. Hofmann, *Die Bedeutung d. Fleischnahrung u.s.w.*, p. 13.

the bowel. Fr. Hofmann noticed that when cellulose was added to a meat diet the assimilation even of the flesh was defective. One can form an approximate notion of the greater or less rapidity of the onward movement of the contents of the bowel by the relative fluidity of the fæces.

The copious evacuation of undigested nutriment in a vegetable diet is also dependent in part on the fact that as a rule such foods are more bulky than those of animal origin. With most vegetable foods it is necessary, in order to meet the demands of the organism, that much larger quantities should be ingested than with an animal or a mixed diet—a fact the explanation of which is to be found in the comparison shown in a foregoing table.[1]

On the utilisation of the different animal and vegetable foods in the digestive canal of the healthy man numerous observations have been published of late; M. Rubner in particular has conducted several very comprehensive series of experiments.[2] The results obtained by these investigations are of such importance in the dietary of the sick that I shall describe them concisely in this place.

A. Utilisation of Animal Food.

Flesh, even when taken in very large quantities, is utilised to a remarkable extent. Thus J. Ranke consumed one day 1,832 grammes of beef, and on the next 2,009 grammes of venison, 5·2 per cent. of the contained nitrogen being evacuated with the fæces on the first day of the experiment, and 12·4 per cent. on the second. But this enormous consumption was so soon followed by such a repugnance to flesh and tendency to vomiting that the experiments could not be extended over another day.[3]

Rubner in two series of experiments, in each of which he consumed large quantities of roast beef for three days continuously, obtained the following results:—

[1] See 'Phys. des allg. Stoffwechsels und der Ernährung,' by C. v. Voit, in L. Hermann's *Handb. der Physiol.*, vol. vi. part i. 1881.

[2] M. Rubner, 'Ueber die Ausnutzung einiger Nahrungsmittel u.s.w.,' *Zeitschr. f. Biol.* vol. xv. p. 115.

[3] J. Ranke, *Arch. f. Anat. u. Phys.*, 1862.

Total Amount Ingested					Percentage Lost in Fæces			
Raw Meat	Dry Matters	Nitrogen	Fat	Ash	Dry Matters	Nitrogen	Fat	Ash
3516	919	119·5	71·9	45·7	5·6	2·8	17·2	21·2
4306	1100	146·3	62·6	55·9	4·7	2·5	21·1	15·0

In both sets of experiments the microscope could detect in the evacuations broken-down muscular fibres, which are not found when smaller quantities of meat are taken and digestion is normal.

Equally successful was the utilisation of hard-boiled eggs. When in the course of two days 1,896 grammes of fresh eggs=495 grammes of dry egg substance, containing 41·5 grammes of nitrogen, 206·7 grammes of fat, and 20·9 grammes of ash, were eaten the percentage of each lost in the fæces was of

Dry substance, 5·2 per cent. Fat, 5 per cent.
Nitrogen, 2·9 per cent. Ash, 18·4 per cent.

Milk gave in Rubner's experiments on adults a more copious elimination with the fæces than did the animal foods already mentioned, the loss of salts, especially those of lime, being greatest. The utilisation of the organic constituents of the milk is on the other hand little less perfect than in the case of flesh and eggs. One experiment lasting three days, and three of one day each, during which milk only was taken, gave the following results :—

Duration of Experiment	Total Weight Ingested						Loss per cent. in Fæces			
	Fresh Milk	Dry Substance	Nitrogen	Fat	Sugar	Ash	Dry Substance	Nitrogen	Fat	Ash
3 days	7315	915	46·1	285·3	307·2	53·4	7·8	6·5	3·3	48·8
1 day	2050	265	12·9	79·9	86·1	15·0	8·4	7·0	7·1	46·8
1 ,,	3075	397	19·4	119·9	129·1	22·4	10·2	7·7	5·6	48·2
1 ,,	4100	530	25·8	160·0	172·2	29·9	9·4	12·0	4·6	44·5[1]

When milk and cheese were administered together the mixed foods were very well assimilated; only when an excessive amount of

[1] J. Forster found, after prolonged observations, that the utilisation of milk in the infant was far more perfect than in the adult, since only 6·3 per cent. of the dry substance was passed with the fæces. Of the dried milk stools 30 to 40 per cent. consisted of fat and 34 per cent. of ash (*Mitth. d. morph.-phys. Gesellsch. zu München*, No. iii.).

cheese (517 grammes) was taken was the waste of nutriment by the fæces greater. In Rubner's opinion this is probably to be explained by the fact that the coagula of milk casein, which usually form large and coherent masses, are much finer in the presence in the stomach of morsels of cheese.

B. Utilisation of Vegetable Foods.

The several kinds of bread are assimilated by the human digestive organs in very different degrees, as will be seen from the following tabular view of G. Mayer's experiments:—

Kind of Bread	Ingesta			Loss per cent. by Fæces		
	Dry Substance	Nitrogen	Ash	Dry Substance	Nitrogen	Ash
Horsford-Liebig bread . .	436·8	8·7	24·7	11·5	32·4	38·1
Munich rye bread . . .	438·1	10·5	18·1	10·1	22 2	30·5
White wheaten bread . .	439·5	8·8	10·0	5·6	19·9	30 2
Pumpernickel . . .	422·7	9·4	8·2	19·3	42·3	96·6 [1]

Rubner in his experiments arrived at similar results, establishing the fact that white bread is very well digested, whereas black [rye] bread is the reverse, as the next table shows.

Kind of Bread	Ingesta				Loss per cent. by Fæces			
	Dry Substance	Nitrogen	Carbohydrates	Ash	Dry Substance	Nitrogen	Carbohydrates	Ash
Three days' experiments with white bread . .	1364	22·8	1173	29·9	5·2	25·7	1·4	25·4
Ditto	2338	39·1	2010	51·2	3·7	18·7	0·8	17·3
Two days' experiments with black bread . .	1529	26·61	1319	39·5	15·0	32·0	10·9	36·0

Rubner found the so-called *Spätzel* and macaroni or *Nudeln* behave as regards their assimilation much the same as white bread, as the following table, exhibiting the loss in the fæces in several experiments, will show:—

[1] G. Mayer, *Zeitschr. f. Biol.*, vol. vii. 1871.

	Spätzeln	Macaroni Nudeln	Macaroni Nudeln
Dry substances . .	4·9 per cent.	4·3 per cent.	5·7 per cent.
Nitrogen . . .	20·5 ,, ,,	17·1 ,, ,,	11·2 ,, ,,
Carbohydrates . .	1·6 ,, ,,	1·2 ,, ,,	2·3 ,, ,,
Fat	—	5·7 ,, ,,	7·0 ,, ,,
Ash	20·9 ,, ,,	24·1 ,, ,,	22·2 ,, ,,

Rice and maize must also be referred to those vegetable foods which are well assimilated by the human digestive organs.

In two series of experiments conducted by Rubner with risotto and polenta the waste per cent. by the fæces was—

	Risotto	Polenta with Parmesan Cheese
Of dry substances .	4·1 per cent.	6·7 per cent.
,, nitrogen . .	20·4 ,, ,,	15·5 ,, ,,
,, fat	7·1 ,, ,,	17·5 ,, ,,
,, carbohydrates .	0·9 ,, ,,	3·2 ,, ,,
,, ash . . .	15·0 ,, ,,	30·0 ,, ,,

On the utilisation of the leguminosæ there are several experiments of Woroschiloff bearing on the value of peas.[1] Then others by Strümpell bring out clearly the great influence of the mode of cooking on the digestibility of the leguminosæ. For four consecutive days dishes composed of the meal of these seeds prepared with the help of milk, butter, and eggs were consumed. By these means a total of 875 grammes of dry substances, containing 36·9 grammes of nitrogen, were ingested, and the loss by the fæces was but 8·2 per cent. of the nitrogen taken in. In a second experiment lentils were administered, simply soaked in water and then boiled, after which 40·2 per cent. of the nitrogen was eliminated unused.[2]

Rubner conducted his series of experiments as to the digestion of peas on the human subject; in the first only a moderate amount, but in the second an excessive, of these was administered; the percentage lost by the fæces was as follows:—

	1st Series	2nd Series
Of dry substances .	9·1 per cent.	14·5 per cent.
,, nitrogen . . .	17·5 ,, ,,	27·8 ,, ,,
,, carbohydrates .	3·6 ,, ,,	7·0 ,, ,,
,, ash . . .	32·5 ,, ,,	38·9 ,, ,, [3]

Experiments with potatoes, carrots, and savoy cabbages showed a very defective utilisation.

[1] Woroschiloff, *Berl. klin. Wochenschr.*, 1873, No. 8, p. 90.
[2] A. Strümpell, *Deutsch. Arch. f. klin. Med.*, vol. xvii. 1876.
[3] M. Rubner, *Zeitschr. f. Biol.*, vol. xvi. p. 119.

	Ingesta					Loss per cent. by Fæces				
	Dry Substance	Nitrogen	Fat	Carbohydrates	Ash	Dry Substance	Nitrogen	Fat	Carbohydrates	Ash
Potato . .	2993	34·37	430·3	2154·5	192·1	9·4	32·2	3·7	7·6	15·8
Carrot . .	823	12·94	94·6	562·9	82·5	20·7	39·0	6·4	18·2	33·8
Savoy cabbage	1480	39·5	263·5	—	219·8	14·9	18·5	6·1	15·4	19·3

In order to decide the question whether the human organs are capable of digesting cellulose H. Weiske instituted experiments on the utilisation of celery, cabbage, and carrots. The person experimented on consumed in the course of three days 417 grammes of the dry substance of these vegetables and evacuated 129·3 grammes of dried fæces; a second individual took 353·3 grammes of dry matter and passed 75·7 grammes of dry fæces. Of the unlignified cellulose in the food 62·7 per cent. and 47·3 per cent. respectively was digested.[1]

C. Experiments on the Absorption of Fat.

With a view to ascertaining what amount of fat the human body can absorb Rubner carried out several experiments in which, besides bread and meat, huge quantities of fat in the form of bacon and butter were administered. The results are shown in the following table:—

Quantity of Fat in each Experiment	Ingesta					Loss per cent. by Fæces				
	Dry Substance	Nitrogen	Fat	Carbohydrates	Ash	Dry Substance	Nitrogen	Fat	Carbohydrates	Ash
100 grs. bacon daily .	1090	47·3	198·0	519·2	47·0	8·5	12·1	17·4	1·6	28·5
200 grs. bacon daily .	1222	47·1	389·4	452·8	45·0	9·2	14·0	7·8	6·2	25·1
200 grs butter daily .	1231	45·9	428·1	443·1	51·0	6·7	11·3	2·7	6·2	20·0
Greatest possible quantity of fat .	1562	46·7	701·0	468·7	54·9	10·5	9·2	12·7	6·8	27·7

These experiments show that the absolute quantity of fat passed

[1] H. Weiske, 'Untersuchungen über die Verdaulichkeit der Cellulose u.s.w.,' *Zeitschr. f. Biol.*, vol. vi. 1870.

by the bowels, was almost the same when 200 as when 100 grammes of bacon were taken.

Not until the daily consumption of fat exceeded 351 grammes was the limit of perfect assimilation overstepped. It would seem, therefore, that the passage of fat with the fæces does not rise as the consumption but remains the same until a certain maximum ingestion is exceeded, when the assimilation of fat rapidly declines.

They also showed that the utilisation of bacon is less than that of butter, which Rubner attributes to the latter not being enclosed in fat cells.

Lastly, it appears from the experiments under consideration that the utilisation of other foods is influenced by these large quantities of fat, at least that of the carbohydrates was less complete than when smaller amounts were given.

It need scarcely be said that many pathological conditions, and especially diseases of the digestive organs, may greatly influence the utilisation of the several alimentary principles and articles of food. Unfortunately we possess at present very few positive data, and these few relate almost exclusively to febrile states; we therefore shall not discuss them until we come to the chapter treating of fevers. It is much to be hoped that before long the utilisation of nutriment in various pathological processes will be made the subject of numerous experiments, since points of the highest importance in the treatment of the sick cannot fail to be brought to light thereby, for it is absolutely necessary to a rational dieting of sick persons that we should know how much of any given form of nourishment is absorbed and how much passes through the bowel unused.

Moreover, such experiments with single articles of food under different circumstances will go far to fill up the gaps in our knowledge of their digestibility which at present cannot be got over. In all such experiments we have to contend with like difficulties to those already indicated in the question of the digestibility of food, with this difference, that utilisation, as distinguished from digestibility, can, in individual cases at least, be measured with the utmost exactness.

THE DEMAND OF THE ORGANISM FOR NUTRIMENT.

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vol. xv. 1879. See also the various Text Books and Systems of Physiology, especially C. Voit's 'Phys. des allg. Stoffwechsels u. d. Ernährung' in L. Hermann's *Handb. der Phys.*, vol. vi. part i., Leipzig, 1881.

UNDER ordinary circumstances the normal organism is led by the calls of hunger to take the amount of food requisite to cover the waste and to maintain the material *status quo* of the entire system; the general sense of comfort and strength giving from time to time indications as to whether the nourishment taken is sufficient to cover all the output and to prevent any loss of weight or energy. These sensations are, however, by no means an absolute measure of the needs of the organism, for the sense of hunger cannot accurately indicate their higher and lower limits, and is, at least temporarily, satisfied by the ingestion of unsuitable food. In fact closer observation shows that in arbitrarily chosen diets errors are by no means rare, for, on the one side, a luxurious indulgence and, on the other, an insufficient employment of certain aliments are of frequent occurrence.

On these grounds alone it would be desirable that the question of the amount of nutritive materials required by the organism under different conditions should be answered on scientific data. This is the more urgent when a fixed dietary is laid down for persons who are deprived of any choice in the matter, as the inmates of prisons, asylums, and other institutions. Lastly, it is of the highest importance in the dieting of the sick to know what amount of nutriment is necessary to meet the demands of the system without any change being caused in its general condition. The problem of determining what amount of food is adequate to all demands under various circumstances is a most complex and difficult one, the conditions for the solution of which have only recently been complied with.

In order to ascertain the material requirements of the normal man, the attempt has been made to learn how much food is habitually taken by different men, and how much nutriment is contained in the rations of armies, or in the diet of the subjects of empirical observation.

The direct estimation of the intake is not of itself enough to prove that the dietary in question corresponds to the actual wants of the organism, for there exists no arrangement in the body by which the supply can be exactly regulated to the demand. In such enquiries we can only learn what amount of food men are accustomed to take under different circumstances and guided only by their subjective sensations, their bodily weight and capability of exertion undergoing meanwhile no appreciable change.[1] But it is certain that a control of the food taken would in many cases lead to very incorrect conclusions, since habit in some and force of circumstances in others overrule the true expression of the natural wants; yet, taken as a whole, men are able to form a correct estimate of their requirements under all ordinary circumstances, so that an examination of many dietaries approved by experience affords an important basis on which to form a judgment as to the quantity of food necessary under various conditions. At the same time we must remark that it appears desirable to obtain the mean value of as many observations as possible, since the actual consumption of food in daily life varies from time to time, although averaging the same over longer periods, so that the body does not exhibit any perceptible change of condition.

In course of time a mass of observations on the diet of the sick has it is true been collected, but it will be generally admitted that these relate rather to the quality than to the quantity of the food, and do not possess the same precision as those made on the requirements of healthy men. As to the question of the quantity of each alimentary principle that may or must be given, the dietaries used in hospitals and confirmed by experience furnish important data. It is, therefore, a matter for congratulation that the dietaries of several large hospitals have within the last few years been submitted to exact analysis in order to ascertain the amount of albumen, fat, and carbohydrates in each prescribed combination. In many diseases it is absolutely

[1] The question whether a given diet is or is not sufficient, and what material result it brings about in the body, cannot be decided by mere observation of the body weight. For the proportion of water in the tissues may vary or the body may take on fat while albuminates are being withdrawn from the system. (See Voit's *Phys. des Stoffwechsels u. d. Ernährung.*)

necessary to regulate the diet from a quantitative as well as from a qualitative point of view, in accordance with clearly defined purposes.

Since the primary use of nourishment is to provide for the replacement of those materials which undergo the most rapid waste in the metabolic processes within the body, it would appear at first sight that the quantity to be administered should be measured by the loss of the corresponding elements from the organism. But the more we learn of the various conditions on which the activity of metabolism depends, the more clearly do we see that the extent of the bodily necessities cannot be immediately deduced from the amount of the products of metabolism. First we observe that the waste is to a great extent dependent on the supply. The greater the mass of material on which the organism has to work the more is, as a rule, eliminated. From an estimation of the products of metabolism one can indeed judge what quantity of various substances must be ingested to furnish the elements contained in the excretions. But the effects of any food cannot be measured by the amount of nitrogen, carbon, &c. therein, since it may easily happen that a food may contain all the elements of the excretions and yet be quite unsuitable. No more can one infer from the total of excreta whether the organism has had a sufficiency of material to work on, or, in default, has been subjecting its own tissues to metabolism. Thus the study of inanition shows unmistakably that one cannot measure the needs of the organism by the actual waste, since, as we have seen, life will soon become extinct if the nutriment given be measured by the metabolism of starvation.

For the solution of the problem of estimating the requirements of the organism under different circumstances it is necessary that we should first learn what influence each food, or mixture of foods, has on metabolism. To know this we must, by keeping an exact account of the total income and output, ascertain under what circumstances a given quantity of nourishment is capable of covering the output, and under what a change of condition whether gain or loss takes place.

In the solution of this question no investigator has taken so large a share as Voit, who, by a host of experiments, established

the conditions of metabolism in the body and the influence of various aliments on these processes, and then, in conjunction with Pettenkofer, having ascertained the balance between the income and output in a number of cases, determined what weights of albumen, fat, and carbohydrates respectively were needed to meet the requirements of the organism, and what became of any excess of nutriment.

In the course of these researches it became evident that the consumption of matter in the system was, even under normal conditions, very variable and dependent, on the one hand, on the general condition and state of nutrition of the body, and, on the other, on the amount of work to be done, external circumstances also co-operating in the result. Besides which, a number of pathological conditions were found to influence the metabolic processes both qualitatively and quantitatively.

On a review of all the circumstances regulating the assumption of nutritive materials we must conclude that no rules of universal validity can be laid down, but that each individual organism presents a distinct case, subject, moreover, to continual changes through external or internal circumstances. Consequently the amount of food required by different persons can, as a rule, be estimated only by averages deduced from numerous experiments and the experience of daily life, subsequently, if possible, adapted to the individual circumstances.

Of all the factors regulating the weight of nourishment required by different individuals the two most important are undoubtedly bodily development and the work to be performed. And it admits of no question that a powerful hard-working man requires more food than a puny and inactive one. Pettenkofer and Voit determined the total elements of the incoming and outgoing in the case of a powerful man of 69·5 kilog. weight both in a state of rest and during work, a summary of the result in each case being shown in the tables on pp. 151–3.

We there see, that during hard work 137 grammes of albumen were consumed, i.e. exactly the same quantity as during rest; but, on the other hand, 173 grammes of fat, and 352 of carbo-

1. *Elements of the Income and Output with an Abundant Diet and during Rest.*

		H^2O	C	H	N	O	Ash
Income :							
Meat . .	139·7	79·5	31·3	4·3	8·50	12·9	3·2
White of egg	41·5	32·2	5·0	0·7	1·35	2·0	0·3
Bread . .	450·0	208·6	109·6	15·6	5·77	100·5	9·9
Milk . .	500 0	435·4	35·2	5·6	3·15	17·0	3·6
Beer . .	1025·0	961·2	25·6	4·3	0·67	30·6	2·7
Suet . .	70·0	—	53·5	8·3	—	8·1	—
Butter . .	30·0	2·1	22·0	3·1	0·03	2·8	—
Starch . .	70·0	11·0	26·1	3·9	—	29·0	—
Sugar . .	17·0	—	7·2	1·1	—	8·7	—
Salt . .	4·2	—	—	—	—	—	4·2
Water . .	286·3	286·3	—	—	—	—	—
Oxygen from the air .	709·0	—	—	—	—	709·0	—
	3342·7	2016·3 = 224H 17920	315·5	46·9 224·0 270·9	19·47	920·6 1792·3 2712·9	23·9
Output :							
Urine . .	1343·1	1278·6	12·60	2·75	17·35	13·71	18·1
Fæces . .	114·5	82·9	14·50	2·17	2·12	7·19	5·9
Breath . .	1739·7	828·0	248·60	—	—	663·10	—
	3197·3	2189·5 = 243·3H 1946·20	275·7	4·92 243·30 248·22	19·47	684·0 1946·2 2630·2	24·0
Balance :	+ 145·4	—	+ 39·8	+ 22·0	—	+ 82·7	− 0·1

There were, therefore—

	Taken in	Destroyed	Stored up
Albumen	137	137	—
Fat	117	52	65
Carbohydrates	352	352	—

hydrates. During a twenty-four hours' fast the same man had subsisted on 80 grammes of meat with 216 of fat.

For the purpose of comparison Pettenkofer and Voit ascertained the physical economy of a small and ill-nourished man

2. *Elements of the Income and Output with an Abundant Diet and during Work.*

		Water	C	H	N	O	Ash
Income:							
Meat . .	151·3	91·05	31·30	4·32	8·50	12·90	3·20
White of egg	48·1	38·78	5·0	0·70	1·35	2·0	0·3
Bread . .	450·0	208·6	109·6	15·6	5·77	100 5	9·9
Milk . .	500 0	435·4	35·25	5·55	3·15	17·0	3·65
Beer . .	1065·9	999·6	26·57	4·48	0·69	31·77	2·83
Suet . .	60 2	—	46·05	7·16	—	6·98	—
Butter . .	30·0	2·1	22·0	3·1	0·03	2·80	—
Starch . .	70·0	11·0	26·1	3·9	—	29·0	—
Sugar . .	17·0	—	7·2	1·1	—	8·7	—
Salt . .	4·9	0·09	—	—	—	—	4·81
Water . .	489·1	479·91	—	—	—	—	0·18
Oxygen from the air .	8006·1	—	—	—	—	1006·1	—
	3883·6	2266·53 = 251·83H 2012·70	309·17	45·81 251·83 297·74	19·49	1217·75 2014·7 3232·45	24·88
Output:							
Urine . .	1261·1	1194·2	12·6	2·75	17·41	14·74	19·4
Fæces . .	129·0	94·1	14·5	2·17	2·12	7·19	5·9
Respiration .	2545·5	1411·8	309·2	—	—	824·8	—
	3932·6	2700·1 = 300H 2400·10	336·3	4·92 300·0 304·92	19·53	846·43 2400·10 3246·53	25·3
Balance:	−49·0	—	−27·13	−7·10	−0·04	−0·04	−0·42

during rest on an ample diet. The elements of the income and output gave the following proportions (see table on next page.)

On the strength of these and numerous other observations Voit has fixed on 118 grammes of albumen (= 18·3 N and 63 C) and with this 265 grammes of carbon in the form of fats and carbohydrates, making a total of 328 grammes of carbon as the average requirements of a moderate worker. Other observers have come to closely similar conclusions by reckoning the nutriment contained in the diet. Thus Moleschott demands 230 grammes of albumen, 40 grammes of fat, and 550 grammes of carbohydrates = 20 N and 325 C for a working man. Playfair fixed the normal ration of an adult at 119 grammes of albumen, 51 grammes of

		Water	C	H	N	O	Ash
Income :							
Meat . .	151·1	90·85	31·3	4·30	8·50	12·90	3·20
White of egg	61·8	52·48	5·0	0·7	1·35	2·0	0·3
Bread . .	450·0	208·60	109·6	15·6	5·77	100·5	9·9
Milk . .	509·6	443·76	35·93	5·61	3·21	17·33	3·72
Beer . .	1012·7	949·71	25·25	4·25	0·66	30·19	2·69
Suet . .	58·8	—	44·98	7·0	—	6.80	—
Butter . .	30·	2·10	22·0	3·10	0·03	2·80	—
Starch . .	70·	11·0	26·1	3·9	—	29·0	—
Sugar . .	17·	—	7·2	1·1	—	8·7	—
Salt . .	4·3	0 08	—	—	—	—	4·22
Water . .	41·4	41·38	—	—	—	—	0·02
Oxygen from the air .	600·7	—	—	—	—	600·7	—
	3007·4	1799·96 =199·9H 1600·00	307·36	45·46 199·9 245·36	19·52	810·92 1600·0 2410·92	29·05
Output :							
Urine . .	1069·6	1005·7	12·7	2·80	18·03	12·37	18·0
Fæces . .	137·1	105·3	14·58	2·17	2·12	7·71	5·9
Respiration .	1597·8	902·6	189 6	—	—	505·60	—
	2804·5	2013·6 =223·7H 1789·90	216·88	4·97 223·7 228·67	20·15	525·68 1789·90 2315·58	23·90
Balance :	+202·9	—	+90·48	+16·69	−0·63	+95·34	+0·15[1]

carbohydrates.[2] Forster found the following in the diet of several individuals of different occupations.

So long as it was assumed that an amount of albumen was

	Albumen	Fat	Carbohydrates	N	C
Labourer, 36 years old	133	95	422	21	321
Joiner . . .	131	68	494	20	342
Young surgeon . .	127	89	362	20	297
,, . . .	134	102	292	21	280
Powerful old man .	116	68	345	—	—

consumed in the body corresponding to the work done, it was naturally held that the supply of albumen was of the highest

[1] Pettenkofer and Voit, 'Untersuchungen über den Stoffverbrauch des normalen Menschen, *Zeitschr. f. Biol.*, vol. ii.; also C. v. Voit, *Physiol. d. allg. Stoffwechsels und der Ernährung, u.s.w.*

[2] See especially Voit, *Gutachten über die Kost in den Volksküchen.*

importance in fitting the body for the exercise of function. In fact several enquiries showed that men in the habit of undergoing great exertion took large quantities of albumen with their food. According to Playfair the diet of men undergoing the following amounts of exertion should contain the respective proportions of albumen indicated.

	Albumen	Fat	Carbohydrates	C
Minimum or subsistence diet	57	14	340	190
Rest	71	28	340	210
Moderate movement . .	119	51	530	337
Hard work	156	71	567	380
Intense exertion . . .	184	71	567	405 [1]

Now, however, it has been proved, chiefly through the researches of Voit, that the consumption or metabolism of albumen in the body is not raised in the least by the most laborious efforts; it is the non-nitrogenous materials only whose consumption is increased by activity. This fact is in no way opposed to the matter of experience, that the body requires a more liberal supply of albumen during hard labour; it rather tends to counteract false conclusions from these results of experience and to make the connection clear. There can, of course, be no doubt that a labourer requires for the performance of a hard task powerfully developed and well-nourished muscles—that is, a large proportion of albuminous tissue in the body, for the maintenance of which a corresponding amount of albuminous food is necessary, as all experience of intense bodily activity goes to show. But a weakly or puny individual will not be rendered capable of any greater efforts by an abundant supply of albuminous food; such power can only follow slowly by increased muscular development consequent on an improved state of nutrition.

For the same reason convalescents who have lost a large part of the albumen of the tissues through prolonged illness must make good the loss before they can again undertake the work they had been previously used to,[2] since the body has the

[1] Quoted by Voit in his *Phys. d. allg. Stoffwechsels*, p. 521. Voit, however, attaches a mark (?) to the 57 grammes of albumen in the subsistence diet and 71 grammes in that of rest, since he believes them to be far too low unless Dr. Playfair's subjects were unusually small.

[2] For an exhaustive treatment of this subject see Voit, *Phys. der allg. Stoffwechsels u.s.w.*; also Hamilton Bowie, 'On the amount of Albumen

faculty of maintaining itself in equilibrium on very different quantities of nutriment, provided that certain limits are not overstepped either way. It is clear that life could, under special circumstances, be supported on a much smaller amount of food than a strong working man would need; but at the same time the capability of exertion would be proportionately reduced. It is only possible to maintain the bodily equilibrium on a scanty diet when the individual is feeble or of small frame and when no great muscular effort is called for. The so-called subsistence diet without work of Dr. Playfair appears to be sufficient for such cases only, but a strong and well-nourished man would lose flesh and be reduced to a low state of nutrition. A considerable reduction of nutriment can, however, be made in old age when all the organs, and especially the voluntary muscles, are more or less atrophied. Thus J. Forster, enquiring into the diet in an institution for the widows of beneficed clergymen, found that a number of the old ladies were satisfied with an average allowance of 67 grammes of albumen, 38 grammes of fat, and 266 of carbohydrates, while others of the inmates required one somewhat larger, viz. 80 grammes of albumen, 49 grammes of fat, and 266 of carbohydrates.[1]

Some diseases of the spinal cord lead to an extraordinary falling off of the demand for nutriment. Division of the cord is said to be followed by such a reduction of metabolism that the subjects of it seem to bear a strong physiological resemblance to cold-blooded animals.

I do not know whether these views are founded on direct experiment, or gathered from the phenomena of the temperature, which falls remarkably after destruction of the cord. The fact is that the interchange of gases is in many ways affected by nervous impressions, but the metabolism of albumen suffers no such changes. It is asserted

required by an Ordinary Labourer,' *Zeitschr. f. Biol.*, vol. xv. In the latter treatise will be found several doubts and reflections which Beneke, in his essay 'Zur Ernährungslehre des gesunden Muschen' (*Schriften d. Ges. f. Beförderung d. ges. Naturwiss. zu Marburg*, xi. 1878), has cast on Voit's views as to the amount of food required by different men, shown to be groundless. The assertion of Beneke that he could maintain himself at a uniform weight of 62 kilogrammes, on 94 grammes of albumen, 109 grammes of fat, and 284 grammes of carbohydrates stands by no means alone, but so frugal a diet is certainly insufficient for a strong and hard-working man.

[1] J. Forster, 'Beiträge zur Ernährungsfrage,' *Zeitschr f. Biol.*, vol. ix.

by many observers that during nocturnal rest the absorption of oxygen and the evolution of carbonic acid appear to be lessened, and it is certainly so in curare poisoning and after division of the spinal cord. Voit found the evolution of carbonic acid in the case of a powerful labouring man, who suffered from fracture of the eight dorsal vertebræ with paralysis of the lower half of the body, 38 per cent. less than in an ordinary healthy man.[1]

A surprising diminution of the desire for food is frequently noticed in the insane, but it is not, so far as I know, determined whether it consists in a lessened activity of tissue change, or an abnormal state of the feeling of hunger.

Only when considerations of economy compel one to eke out the supply of food are we justified in reducing a healthy organism to a lower state of vitality by providing only the minimum allowance: in all other cases a certain amount of *luxus* is decidedly advantageous. The consequences of an insufficient diet will be found, if closely looked into, to consist not only in a loss of weight, and diminished capability of exertion and functional activity, but in many cases in a positive and permanent injury to the health, the constitution gradually deteriorating and, above all, the power of resisting various external unfavourable influences being greatly lessened. The truth of this has often been proved on a large scale in times of general distress and famine by the enormous mortality that then prevails from all causes. But even in daily life one has ample opportunities of learning the grave consequences of an insufficient diet, and it is one of the most urgent duties of the hygienist to demonstrate, as forcibly as possible, the close connection subsisting between many forms of disease and insufficient nourishment.

In all cases in which we have to deal with the improvement of a depressed state of nutrition, the task of therapeutics consists in so regulating the supply of nourishment that a steady increase of the constituents of the body shall take place until the appearance, weight, and sense of returning strength bear witness that the individual has regained his normal con-

[1] Pflüger, *Arch. f. d. ges. Physiol.* vol. xviii. 1878, 'Röhrig u. Zuntz,' ibid. vol. iv. 1871, 'Pettenkofer u. Voit,' *Zeitschrift f. Biol.* vol. ii. 1866, Voit, ibid. vol. xiv. 1878, see also Voit, *Physiol. d. allg. Stoffswechsels u. d. Ernährung.*

dition. But when in consequence of insufficient nourishment the entire organism has been seriously injured or diseases of single organs have been induced, although a liberal diet will not by itself attain the end in view, a judiciously guided diet, and even, under special circumstances, a dietetic course, will form an important and essential part of the treatment.

But, on the other hand, there is no doubt that excess no less than long-continued deprivation of food may act unfavourably on the general habit of body and injure the health in many ways. A frequent result of immoderate feeding is an undue and unequal deposition of fat in the organs, especially those of digestion, accompanied by derangements of their functions comprehended under the general designation of abdominal plethora. A too luxurious living does not in all cases lead to an abnormal obesity and its consequences; it may induce derangements of another kind, especially such as have their origin in an unwonted overloading of the digestive organs and in a useless increase of the internal work of the body.[1]

In the opinion of several authorities, as F. W. Beneke, A. Cantani, &c., a diet in excess of the individual requirements gradually leads to an imperfect elaboration of the nutriment taken, and to a 'retardation of metabolism.' The existence of these derangements of function, which are the commencement and causes, or the accompaniments of many diseases, is due, according to Dr. Beneke, to the fact that a part of the food ingested is not reduced within a certain time to the ultimate products of normal assimilation, viz., urea, carbonic acid, and water, and the immediate consequences are, that the products leave the body partly in earlier stages of splitting up than they would under normal conditions, and partly in the natural and ultimate forms, but in abnormally small amounts. Evidence of this incomplete metabolism is to be found in an abundance of oxalic acid in the urine, as well as an increased formation and excretion of urea.[2]

In accordance with the plan of this work, the anomalies of the bodily economy will be discussed so far only as they have a practical bearing on the dietary of the sick. I shall therefore avoid entering any further into the hypotheses above mentioned as to the oxalic and uric acid diatheses, and content myself with the remark that they can

[1] See Immermann, 'Die Fettsucht' in Ziemssen's *Handb. d. Spec. Path. u. Therap.* vol. xiii. p. 2.

[2] F. W. Beneke, *Grundlinien der Pathol. d. Stoffwechsels*, 1874; Arnald Cantani, *Spec. Pathol. u. Therap. d. Stoffwechselkrankheiten*, vol. i. Berlin, 1880.

scarcely be reconciled with the present state of our knowledge of the metabolic processes.[1] We cannot therefore accept unconditionally the further conclusions which these authors draw, especially in regard to therapeutics, from the pathological elimination of oxalic and uric acids, &c.

The demand of an organism for nourishment can be satisfied by the administration of foods of the most varied description, so far as to prevent any loss of the material constitution of the body; but every kind of food capable of maintaining the frame does not equally answer its actual requirements. To satisfy these the several aliments must not only be present in a quantity sufficient to meet the needs of the organism, but also be combined in due proportions. To show that the great majority of our articles of food do not contain the nitrogenous and non-nitrogenous food-stuffs in appropriate proportions Voit has calculated for a number of these what quantity of each would be necessary to furnish on the one hand the nitrogen and on the other the carbon required.

	For 18·3 grms. Nitrogen		For 328 grms. Carbon
Cheese	272	Bacon	450
Peas	520	Maize	801
Lean meat	538	Wheat meal	824
Wheat flour	796	Rice	896
Eggs (18)	905	Peas	919
Maize	989	Cheese	1160
Black bread	1430	Black bread	1346
Rice	1868	Eggs (43)	2231
Milk	2905	Lean meat	2620
Potatoes	4575	Potatoes	3124
Bacon	4796	Milk	4652
Cabbage	7625	Cabbage	9318
Turnips	8714	Turnips	10650
Beer	17000	Beer	13160[2]

From the foregoing table it will be seen how necessary to proper nourishment is a mixture of foods. For, setting aside the question of the waste involved in an exclusively meat diet, few men would be capable of consuming, much less of properly digesting, daily, 2,620 grammes of meat or 4,575 of potatoes, and where such a diet is taken, it is at the expense of the

[1] Compare Hoppe Seyler, *Physiol. Chem.*, part iv. 1881; also P. Fürbringer, 'Zur Lehre von Diabet. mellit., *Deutsch. Arch. f. klin. Med.* vol. xvi. p. 499.

[2] C. von Voit, *Physiol. d. allg. Stoffwechsels u. d. Ernährung*, p. 497.

functional energy and health of the individual. Even milk, which presents the ideal nourishment of the infant, is not suited for the sole food of the adult, i.e. of a working man, since 4,652 grammes are necessary to furnish the carbon required by the ordinary labourer.

The amount of carbon which, according to Voit, meets the needs of an average working man would be furnished by 346 grammes of fat or 596 grammes of starch, if the necessary amount of albumen were given therewith. Experience shows that few men could continue for long to take so large a quantity either of fat or of carbohydrates, and probably it is better physiologically, as it is usual in practice, to take the carbon partly in the form of fat and partly of farinaceous foods. Such a mixture maintains the various parts of the digestive organs in healthy action and thus lightens the work of each. Besides, the carbohydrates are not capable of replacing the fats beyond a certain point; a proportion of fat would appear necessary to a well-composed diet, more especially if much exertion is required or deposition of fat desired. In fact, experience shows that most men lay great weight on the addition of a portion of fat to their diet, and do not, unless compelled by circumstances, satisfy their demand for carbon by means of carbohydrates only. On the other hand it is to be remarked in respect of fat, which has been shown to be easily assimilated, that considerable individual differences exist, and that many persons are either quite unable to tolerate larger quantities or can do so only under special circumstances.[1]

An injudicious combination of the aliments, especially an excess of one along with a deficiency of another, may, no less than an insufficient amount of food, gravely affect the general constitution and induce changes in particular structures which must be looked on as pathological, and which may lay the foundation of serious general derangements of nutrition or diseases of single organs.

An irregular and inappropriate diet, in which one group of food-stuffs is represented in excess while another is greatly below

[1] According to the observations of J. Felix, (*Deutsch. Vierteljahrsschr. f. öff. Gesundheitspflege*, vol. iii., 1871), a deficiency of fat in the food would appear to have some influence in the production of scurvy.

the requirements of the normal organism, is far more frequently met with than actual starvation and is in one sense more dangerous, since the mere bulk of food, however unsuitable, gives an illusory sense of satiety and long conceals the mischief at work. The one-sided and defective diet one most often meets with in daily life is that in which there is a deficiency of albuminates, but a great excess of carbohydrates, a proportion owing to the composition of those vegetable foods on which the poorer classes are necessarily largely dependent for support.

Among the consequences of such a diet, which involves an enormous bulk of food, are not only a permanent dilatation of the stomach and bowel, but a tendency to several diseases of the digestive organs. The outward appearance of such persons is to a certain extent characteristic, marked generally by a pale and puffy aspect, due partly to a general excess of water in the tissues and partly to an abnormal deposition of fat. Such a condition of body involves a considerable diminution of power, and of resisting injuries of various kinds, and is, without doubt, closely connected with the development of dyscrasiæ such as scrofulosis, tuberculosis, &c.

Far more rarely the error consists in an excess of albuminates, the non-nitrogenous aliments, especially the carbo-hydrates, being deficient. These persons, who obviously are most often found among the well-to-do classes, appear, as a rule, lean, and present many derangements of circulation and innervation, especially a more or less marked tendency to nervous irritability.[1]

As the aggregate of nutriment demanded is a variable quantity, so is the proportion in which the albuminates and the non-nitrogenous aliments should enter into the diet, the greatest differences in this respect depending on the general habit of body and the work to be done. But in disease the relation between the several aliments found by experience to be best for the human organism in a state of health may have to be changed in one direction or another to a much greater extent, as when metabolism proceeds under abnormal conditions or the system suffers a drain of some of its fluids, &c.

[1] Compare A. Geigel, 'Handb. d. öff. Gesundheitspflege u.s.w.,' in Ziemssen's *Handb. d. Spec. Pathol.*, vol. i. 1875; F. W. Beneke, *Grundlinien der Path. des Stoffwechsels*, lecture v. 'Von den Proportionsstörungen der integrirenden Körperbestandtheile.'

When the demands of an organism have been ascertained, the question arises as to the forms in which the requisite amount of food may be most advantageously provided. The problem would be easy enough of solution were it not that taste and the necessity for change impose on the composition of man's diet imperious conditions which cannot be neglected without injury. To satisfy these conditions men are in the habit of using the most complex mixtures of various foods, the composition of which has been learnt by experience. If one were to attempt to make a perfect food which should contain just the proper proportion of albumen, fat, carbohydrates, and salts, without reference to the teachings of experience as to taste, &c., the result would probably be an almost if not utterly inedible *mixtum compositum*. A too great monotony in diet is an error the consequences of which are often enough seen in daily life, and are known to most men by their own experience.

From what has gone before it will be seen that the regulation of a diet for such classes of persons as cannot satisfy their wants by their own free choice is a matter of great difficulty, the more so when motives of economy are brought into consideration; for the majority of those vegetable foods which can be obtained at a low price are not easily digested, a fact that must never be forgotten.

In daily life the difficulties which beset the scientific arrangement of a normal diet are not felt, since the food is regulated by one's subjective feelings and not by a prescribed formulary, whence it not unfrequently occurs that the quantity taken daily presents considerable variation, though the average corresponds to the needs of the system. But if the dietary of persons who have no choice in the matter is defective or mistaken the effects will be far wider than those of single ill-arranged meals. Besides we have at our service abundant materials drawn from experience both as to the quantity of nutriment required and the combination of food which scientific dietetics has appropriated from practical life and which cannot be dispensed with.

As a rule man divides his daily allowance of nutritive materials between several meals, since it is scarcely possible for him to take the whole quantity required in the twenty-four hours at one time and to submit it to the action of his diges-

tive apparatus, and, as J. Forster has well shown, it has not the same effect on the functions of the body if the materials for metabolism are presented to the organs at one time and in great excess or in smaller quantities at intervals, a greater uniformity in the metabolic processes being certainly attained by the latter course.[1] In general three meals are taken, but the labouring population, whose diet is largely composed of vegetables, usually take some bread between their proper meals. The principal meal is in some countries taken at noon, in others in the evening, without any reasons being discoverable unconditionally in favour of one or the other time of day.[2] It must, however, be pronounced inexpedient to take a heavy meal late in the evening and shortly before going to sleep, since the activity of digestion abates during sleep, and over-loading of the organs of digestion disturbs the rest.

SUNDRY CONSIDERATIONS DIRECTED TO THE SOLUTION OF THE QUESTION AS TO THE QUANTITY OF FOOD TO BE ADMINISTERED IN DISEASE.

The data we possess as to the needs of the normal organism under different circumstances must find their application in the dietary of sick persons. At the same time the question will present itself in each individual case, What material effects will be brought about in the body by the supply of nutriment, and what functional activities be evoked? Above all will it be neeessary to assure oneself whether the food can entirely replace the waste of the system, or whether such a result is to be attained only in part; or, again, it appears on other grounds that a change in the general nutrition is indicated.

To ascertain what quantity of food is necessary to obtain the material effeets contemplated it is essential that we should know first the amount of waste which occurs in most pathological conditions. We must further enquire whether the several aliments will exert the same effects on the metabolic

[1] J. Forster, 'Beitr. zur Ernährungsfrage,' *Zeitschr. f. Biol.*, vol. ix. 1873.

[2] According to the calculations of Voit the Munich workmen take 50 per cent. of the albumen, 61 per cent. of the fat, and 32 per cent. of the carbohydrates of their daily rations in the midday meal. J. Forster arrived at a like conclusion from an examination of the diet of two medical men.

process and the functions of the organism under abnormal conditions of cell action as in a state of health. That this is not always the case is shown, for example, by the behaviour of the carbohydrates in diabetes mellitus.

In the healthy man the material results desired may often be obtained by foods of very different kinds, since both qualitatively and quantitatively the digestive organs permit a considerable latitude in this respect. But it is quite otherwise in many diseased conditions in which the activity of the digestive organs is more or less impaired, so that the ingestion of food is reduced to the narrowest limits. In all such cases the demands of the organism measured by the amount of waste can be satisfied so far only as the capabilities of the digestive organs allow. It is scarcely necessary here to insist on the fact that the sense of hunger, the longing for food, furnishes an important indication of the capacity for digestion.

The solution of this question, how much of each food stuff is expedient in the diet of the sick, is attended by still further difficulties when we have to do with the acute febrile states; for in these cases it is quite possible to bring about an elevation of temperature by means of food, since, though the food stuffs undergo the same splitting up in febrile as under normal conditions, they do not always seem to induce the same effects. It is at least very probable that with very high temperatures it would still be impossible entirely to prevent the waste of the elements of the body itself even if it were practicable to administer he most liberal allowance of albumen, fat, and carbohydrates. These considerations must not be allowed to outweigh the greater danger of prolonged inanition; besides there is no doubt that, hough we cannot altogether prevent the waste of tissues occurring in fevers, we can by judicious feeding considerably educe it, the functional capabilities of the organs being at the ame time greatly enhanced.

The separate factors, therefore, on which the amount of ourishment to be administered to the sick must necessarily epend scarcely admit at present of being determined even n general principles; far less are we in a position to lay own rules for an accurate estimate in individual cases. A ide field lies open for future research in this direction, for

our knowledge as to the amount of waste and the effects of each foodstuff, as well as of the digestibility and utilisation of various articles of food under different pathological conditions, is at present very unsatisfactory. Such researches are attended with many difficulties, and the great multiplicity of conditions is such that only by means of numerous observations and great labour can any rules of general application be obtained. Meanwhile nothing remains but to order the diet of the sick as experience has shown to be best; obviously we cannot as a rule enquire what amount of food a man would seek under particular pathological conditions if guided by his own free will alone; but we shall submit to a close scrutiny the prescriptions which physicians have laid down for the diet of their patients. For this enquiry the dietaries in use in different hospitals furnish doubtless the most valuable material if their composition be known, and also the principles by which any deviation from the sheets, when permitted, is guided. In 1853 F. W. Beneke published a statistical report on the dietaries of the principal hospitals of London, including several institutions for convalescents, with statements of the relative proportions of nitrogenous and non-nitrogenous matters contained in each. From this we extract the following tables.[1]

	Cooked Meat	Bread	Potatoes	Sugar	Meal	Fat	Milk	Cocoa	Beer	Rice
Middlesex Hospital	117	351	234	—	44	—	292	—	—	—
St. Bartholomew's Hospital . .	117	351	234	—	29	22	292	—	585	—
Hospital for Consumption . .	117	351	154	—	4	—	401	29	—	—
St. George's Hospital . . .	175	351	234	—	44	29	292	—	585	—
Westminster Hospital . . .	224	409	351	—	88	—	292	—	—	—
German Hospital, Dalston . .	117	351	234	—	44	29	585	—	—	—
Woolwich Hospital	159	351	468	15	—	—	292	—	—	22
Royal Sea Bathing Infirmary, Margate . . .	217	501	217	—	—	12	334	8	1,169	37
Metropolitan Establishment, Margate[2] . .	125	409	334	29	—	25	146	—	209	—
Château Bellevue .	171	409	334	15	—	25	292	—	585	12

[1] Beneke, *Arch. f. physiol. Heilk.*, 12th year, 1853.

[2] For scrofulous children, 10 to 16 years of age.

From which we may calculate the proportions of albumen, fat, and carbohydrates.[1]

	Albumen	Fat	Carbohydrates
Middlesex Hospital	85	28	297
St. Bartholomew's Hospital . . .	83	50	291
Hospital for Consumption . . .	83	32	254
St. George's Hospital	100	65	308
Westminster "	125	43	388
German "	97	68	309
Woolwich "	87	34	347
Royal Sea Bathing Infirmary, Margate .	123	55	438
Metropolitan Establishment " .	83	48	359
Château Bellevue	102	60	364

In the year 1856 W. Hildesheim in his 'Normal Diet' gave a calculation of the diets adopted in the Russian lazarets. These consist of an ordinary diet, a number of extras, and of several beverages, among which are beer, brandy, wine, gruel, barley water, rice water, toast water, and milk. The ordinary diet itself is of four different grades, having on an average the following composition :—

	Albumen	Fat	Carbohydrates
1st diet form . . .	125 grms.	19 grms.	508 grms.
2nd " " . . .	84 "	19 "	283 "
3rd " " . . .	56 "	19 "	146 "
4th " " . . .	18 "	18 "	111 "

The dietaries may, by doubling the meat ration or adding extras, be made to assume a great variety, as is seen from the following statement of Hildesheim :—

		Albumen	Fat	Carbohydrates
		Grms.	Grms.	Grms.
1st Diet	*a.* Double meat ration .	164	26	508
	b. Single " " .	125	19	508
	c. With beer as drink .	125	19	548
2nd Diet	*a.* With egg broth . .	123	31	283
	b. Double meat ration .	117	26	283
	c. With 1 lb. of bread .	95	19	338
	d. With coffee . .	89	22	300
	e. With barley water .	87	19	327
	f. With gruel . . .	86	19	313
	g. Single meat ration .	84	19	283
	h. With beer as drink .	84	19	323

[1] 110 grammes of roast meat = 133 grammes of raw, and contains 26·1 grammes of albumen and 14 grammes of fat. Bread contains 9·2 per cent. of albumen and 57·3 per cent. of starch. Compare F. Renk, *Ueber die Kost im Krankenhause zu München.*

		Albumen	Fat	Carbohydrates
		Grms.	Grms.	Grms.
3rd Diet	*a.* With egg broth	95	31	146
	b. With veal and egg broth	91	37	150
	c. Pickled veal	89	32	146
	d. Bouillon	89	26	146
	e. Bread and milk	82	32	178
	f. Rice milk	74	28	191
	g. Milk	71	28	157
	h. Two eggs	68	29	146
	i. Extra roll	67	19	208
	k. Toast and water	67	19	202
	l. Bread soup	66	24	169
	m. Wine ,,	65	24	204
	n. Egg and barley soup	61	28	167
	o. Coffee	61	22	164
	p. Beer soup	60	25	195
	q Barley water	59	19	191
	r. Oatmeal gruel	58	20	176
	s. Rice gruel	58	19	169
	t. Rice water	57	19	158
	u. Single meat ration	56	19	146
	v. Beer as drink	56	19	186
	w. Wine ,,	56	19	161
4th Diet	*a.* Bread and milk at dinner	40	25	122
	b. Bread soup at dinner	25	17	113
	c. Wine soup for dinner	23	17	148
	d. Beer ,, ,, ,,	17	18	132
	e. Semolina ,, ,,	18	18	111
	f. Toast water as drink	33	18	167
	g. One egg	24	23	111
	h. Barley water as drink	21	18	155
	i. Oatmeal gruel ,,	20	19	140
	k. Rice gruel ,,	20	19	134
	l. Rice water ,,	19	19	122
	m. Wine ,,	18	19	126
	n. Sugar	18	19	138

In the opinion of Hildesheim these dietaries, even when combined with extras, are not in all respects adequate to the requirements of disease. He himself sought to determine the proper diet for men under all possible circumstances in Barral's metabolic equivalents, viz. the carbonic acid eliminated in respiration and the nitrogen in the urine and fæces. In this way Hildesheim thought he could lay down formulæ for the diet of the sick, as a standard for which he made use of the metabolic equivalents of inanition. As it is not without interest to know the data from which he deduced his dietaries I will transcribe his proportions verbatim.

'In most diseases the demand for nourishment is so modified that the albuminates and fats must be reduced in quantity or even altogether

withheld, partly because the digestive organs can assimilate them only to a small extent or not at all, partly because there is a large quantity of waste matters in the blood, which must be eliminated before metabolism can resume its normal course, and partly for other reasons. Since, then, the body suffers a continuous loss of the products of metabolism, without assimilation of other matter to replace the loss, it consumes its own substance and loses weight to a corresponding degree, and this the more notably the longer this one-sided metabolism goes on. After the cessation of the disease and during the recovery of the digestive power the demand for these matters returns and a restorative diet gradually replaces the loss.

'It is quite otherwise with the carbohydrates. The demand for respiration remains more or less unaltered in disease, and never sinks lower than the minimum of rest. Even if the pabulum of the blood serve as respiratory material and undergo oxidation into carbonic acid and water, we have in this an indication for their speedy removal from the circulation; the available stock is very soon exhausted, and inanition with its consequence follows if an adequate supply of carbohydrates be not forthcoming from without. Such a spare diet as has long been deemed necessary for the sick, and which withholds the carbohydrates as well as the albuminates and fats, exposes the patient to the danger of inanition, which may very soon take on the character of asthenia.'

In a dietary which Hildesheim constructed, consisting of 12 grades, his idea of the function of the carbohydrates in the organism, according to the propositions given above, is carried out.

		Albumen	Fat	Carbohydrates
		Grms.	Grms.	Grms.
I. Full or convalescent diet	1st grade	146	44	500
	2nd "	132	39	474
	3rd "	116	35	447
	4th "	102	31	421
II. Half diet	5th "	88	26	395
	6th "	73	22	368
	7th "	58	18	342
	8th "	44	13	316
III. Quarter diet	9th "	29	9	289
	10th "	15	5	263
IV. Blank diet	11th "	—	—	237
	12th "	—	—	118

These foodstuffs were to be given in the forms in each of the twelve grades (*see* next page):—

C. Kirchner in his 'Text Book of Military Hygiene,' which appeared in the year 1869, gave a calculation of the diets in use

Grade	Bread	Meat	Butter	Meal	According to Choice				Sugar
					Peas, &c.	Nudeln	Millet	Potatoes	
1	702	234	42	117	234	117	175	701	—
2	643	195	38	117	234	117	175	701	—
3	585	156	35	117	234	117	175	701	—
4	526	117	31	117	234	117	175	701	—
				Groats	Pearl barley	Rice	Groats		
5	466	156	23	117	117	117	117	—	—
6	408	117	19	117	117	117	117	—	—
7	350	78	15	117	117	117	117	—	—
8	292	39	11	117	117	117	117	—	—
	Rolls								
9	176	—	7	176	88	88	88	—	—
10	88	—	5	88	88	88	88	—	88
11	—	—	—	{— 176}	—	—	—	—	{234 117}
12	—	—	—	—	—	—	—	—	117[1]

in the Prussian military hospitals, and states the following as the composition of each meal :—

	Albumen	Fat	Carbohydrates
	Grms.	Grms.	Grms.
I. Breakfast	6·9	11·2	30·9
I. Dinner	43·0	15·9	114·4
I. Supper	6·9	13·0	56·7
I. Bread	46·8	8·8	287·7
Total	112·0	53·0	553·0
II. Breakfast	4·6	7·5	25·4
II. Dinner	38·3	14·7	79·5
II. Supper	5·6	8·9	42·0
II. Bread	23·4	4·4	143·8
Total	76·0	38·0	330·0
III. Breakfast	3·4	5·2	15·1
III. Dinner	25·7	13·5	28·8
III. Supper	3·5	6·8	30·5
III. Bread	11·7	2·2	71·9
Total	45·0	29·0	172·0
IV. Breakfast	3·4	5·2	15·1
IV. Dinner	0·8	2·0	23·7
IV. Supper	3·2	6·1	24·1
IV. Bread	11·4	0·9	53·6
Total	21·0	15·0	137·0

According to Kirchner the various articles of food were distributed as follows :—

[1] W. Hildesheim, *Die Normaldiät.* See also Fr. Renk, *Ueber die Kost im Krankenhause zu München.*

			1st Diet	2nd Diet	3rd Diet	4th Diet
			Grms.	Grms.	Grms.	Grms.
Breakfast		Meal or	52	36	29	29
		Oat groats or	52	36	29	29
		Pearl barley	52	36	29	29
		Butter per quart of soup	14·5			
Dinner		Meat	146	146	146	—
	Dry vegetables	Rice or	88	58	44	—
		Pearl barley or	95	66	44	—
		Peas or	205	146	—	—
		Beans or	205	146	—	—
		Lentils or	205	146	—	—
		Millet or	127	88	63	—
		Nudeln	102	73	44	—
	Dry vegetables with potatoes	Rice with	58	44	29	—
		Potatoes	127	73	44	—
		Pearl barley with	58	44	29	—
		Potatoes	127	73	44	—
		Peas with	146	102	—	—
		Potatoes	219	146	—	—
		Beans with	146	102	—	—
		Potatoes	219	146	—	—
		Lentils with	146	102	—	—
		Potatoes	219	146	—	—
	Green vegetables	Potatoes or	731	585	—	—
		Carrots with	585	439	—	—
		Potatoes	219	146	—	—
		Turnips with	585	439	—	—
		Potatoes	219	146	—	—
		Kohl rüben with	439	292	—	—
		Potatoes	219	146	—	—
		Kohl rabi with	439	292	—	—
		Potatoes	219	146	—	—
		White cabbage with	439	292	—	—
		Potatoes	219	146	—	—
		Savoys with	439	292	—	—
		Potatoes	219	146	—	—
		Green beans with	439	292	—	—
		Potatoes	219	146	—	—
		Green peas with	219	219	146	—
		Carrots	585	439	292	—
		Spinach	—	—	1 peck	1 peck
Supper		Buckwheat groats	73	58	43	43
		Pearl barley or	51	36	29	29
		Oat groats or	51	36	29	29
		Wheat groats or	51	36	29	29
		Potatoes or	585	439	292	—
		Millet or	73	58	43	43
		Bread or	146	102	—	—
		Roll	102	73	58	43
		Meal	51	36	29	29
		Butter	11	7	5	5
Common		Bread	585	292	—	—
		Rolls	—	—	146	73

This diet Kirchner does not consider at all sufficient, although the medical officer is able by means of extras to produce every possible combination. In fact in the Prussian garrison hospitals a liberal supply of extras is the rule.

Description of Extras	Quantity provided with each Diet			
	1	2	3	4
1. Beef steak, beef fillet or thinly sliced .	—	—	146·0	—
Butter	—	—	14·5	—
2. Roast beef. Beef	—	—	146·0	—
Bacon	—	—	7·3	—
3. Mutton cutlet. Mutton . . .	—	—	146·0	—
Butter	—	—	14·5	—
4. Roast mutton	—	—	146·0	—
5. Pork cutlets. Pork	—	—	146·0	—
Butter	—	—	14·5	—
Bread crumbs	—	—	7·3	—
6. Roast pork. Pork	—	—	146·0	—
7. Roast veal. Veal	—	—	146·0	—
Butter	—	—	14·5	—
8. Veal cutlet. Veal	—	—	146·0	—
Butter	—	—	14·5	—
9. Pickled veal. Veal	—	—	146·0	—
Butter	—	—	14·5	—
Vinegar and spices . . .	—	—	—	—
10. Raw ham	—	73·0	73·0	—
11. Mashed potatoes. Potatoes . .	—	—	512·0	—
Butter	—	—	7·3	—
Milk	—	—	36·0	—
12. Rice pudding. Rice	—	—	44·0	44·0
Milk	—	—	286·0	286·0
Sugar	—	—	7·3	7·3
Cinnamon	—	—	—	—
13. Sauerkraut. Cabbage . . .	—	146·0	102·0	—
Fat.	—	29·0	22·0	—
14. Apple sauce. Apples	—	—	146·0	146·0
Sugar	—	—	29·0	29·0
15. Stewed fruit. Fresh fruit . . .	—	—	146·0	146·0
Sugar	—	—	29·0	29·0
16. Dried plums. Plums	—	—	73·0	73·0
Sugar	—	—	14·5	14·5
17. Bouillon. Beef	—	—	146·0	146·0
18. Bouillon with egg. Beef . . .	—	—	146·0	146·0
Egg	—	—	One	One
19. Light-boiled egg	—	—	One	One
20. Wine soup. Light wine . . .	—	—	143·0	143·0
Sugar	—	—	29·0	29·0
(White roll) bread crumbs . .	—	—	14·5	14·5
21. Wine sago soup. Wine . . .	—	—	143·0	143·0
Sago	—	—	29·0	29·0
Sugar	—	—	14·5	14·5
22. Bread and milk. Milk . . .	—	—	430·0	430·0
White bread	—	—	29·0	29·0

Description of Extras	Quantity provided with each Diet			
	1	2	3	4
23. Beer soup. Beer	—	—	286·0	286·0
Bread or	—	—	44·0	—
Roll	—	—	—	29·0
Sugar	—	—	14·5	14·5
Butter	—	—	7·3	7·3
24. Dried plum soup. Plums	—	—	58·0	44·0
Roll	—	—	14·5	14·5
Sugar	—	—	14·5	14·5
25. Bilberry soup. Bilberries	—	—	1 quart	1 quart
Roll	—	—	14·5	14·5
Sugar	—	—	14·5	14·5
26. Chocolate	—	—	44·0	29·0
Milk	—	—	286·0	286·0
27. Cocoa	—	—	14·5	14·5
Sugar	—	—	14·5	14·5
Yolk of egg	—	—	One	One
28. Coffee. Roast coffee	7·3	7·3	7·3	—
Milk	95·0	95·0	95·0	—
Sugar	14·5	14·5	14·5	—
29. Tea. Black or green tea	1·2	1·2	1·2	—
Milk	95·0	95·0	95·0	—
Sugar	14·5	14·5	14·5	—
30. Lemon	—	—	Half	Half
Sugar	—	—	29·0	29·0
31. Butter	—	29·0	29·0	—

In addition the various drinks, as porter, light or strong wines, beer, vinegar, milk, gruel, barley water, rice water and gruel, toast and water, and malt water, may be ordered.

As regards the proportion and amount of the several aliments contained in the usual diet of the Prussian military hospitals there is a statement in the 'Handbook of Military Hygiene,' by W. Roth and R. Lex, which differs little from the calculation of C. Kirchner. According to these authors the several diet forms contain the following quantities of each aliment :—

	I.	II.	III.	IV.
A. *Breakfast :*				
Albumen	7	5	4	4
Fat	12	8	6	6
Carbohydrates	42	29	25	25

	I.	II.	III.	IV.
B. *Dinner:*				
Albumen	50	43	29	2
Fat	20	18	17	2
Carbohydrates	120	90	32	26
C. *Supper:*				
Albumen	8	7	5	4
Fat	14	9	7	6
Carbohydrates	60	46	32	26
D. *Extra bread:*				
Albumen	50	26	14	8
Fat	9	4	2	1
Carbohydrates	300	150	90	50
Total:				
Albumen	115	81	52	18
Fat	55	39	32	15
Carbohydrates	522	315	179	127[1]

In the French military hospitals there are seven diet forms, which, according to the statements of Kirchner, contain the following amount of foodstuffs:—

	Albumen	Fat	Carbohydrates
Full diet	119 grms.	57 grms.	448 grms.
$\frac{2}{3}$ "	91 "	47 "	357 "
$\frac{1}{2}$ "	70 "	39 "	225 "
$\frac{1}{4}$ "	35 "	25 "	134 "
$\frac{1}{8}$ "	19 "	17 "	89 "
Bread diet . . .	14 "	36 "	89 "
Absolute diet . . .	—	—	—

Of bread, besides 40 grammes in soup, there are given with the first five diets from 330 to 40 grammes, of meat from 140 to 35 grammes in the first four diets, as well as rich or thin soup with from 250 to 125 grammes of vegetables. Further, along with the bread and 'absolute' diets, in the latter of which only fluid foods are given, roast or boiled meat, fowl, various soups, vegetables, milk, eggs, fruits, coffee, chocolate, and wine may be given on a medical order within prescribed limits.[2]

In the English army hospitals there are, according to Kirchner, ten different diets, containing the following quantities of albumen, fat, and carbohydrates:—

[1] W. Roth and R. Lex, *Handbuch d. Militärgesundheitspflege*, vol. ii. No. 2, p. 589, 1875.

[2] Cf. Kirchner, op. cit., and Roth and Lex, op. cit.

	Albumen	Fat	Carbohydrates
Tea diet	25	10	188
Soup ,,	27	10	234
Broth ,,	68	30	216
Milk ,,	102	69	354
Low ,,	99	27	328
Fowl ,,	96	44	300
Half ,,	87	59	367
Fish ,,	89	91	353
Meat ,,	102	29	359
Full ,,	107	69	333

These diets are composed of the following quantities of each kind of food :—

	Tea Diet	Soup Diet	Broth Diet	Milk Diet	Low Diet	Chicken Diet	Half Diet	Fish Diet	Meat Diet	Full Diet
Bread	227	227	340	396	396	509	453	509	509	453
Tea	14	7	7	—	7	7	7	7	7	7
Sugar	71	42	42	28	42	42	42	42	42	42
Milk	170	170	170	1,704	170	170	170	170	170	170
Beef	—	—	226	—	—	—	—	—	—	—
Mutton[1]	-	—	—	—	227	—	227	—	227	340
Fowl	—	—	—	—	—	227	—	—	—	—
Fish	—	—	—	—	—	—	—	227	—	—
Butter	—	—	—	—	28	28	28	56	28	28
Potatoes	—	—	—	—	—	—	227	227	227	454
Vegetables	—	—	—	—	—	—	113	—	113	113
Rice	—	—	—	57	—	—	—	—	—	—
Groats	—	—	—	—	—	—	42	—	—	42
Meat	—	—	—	—	—	—	7	—	—	7[1]

According to Parkes the proportion of albumen varies in the diet of English army hospitals from 25 to 102 grammes, that of fat from 9 to 79, and of carbohydrates between 186 and 420 grammes.[2]

According to Roth and Lex there are in the Russian military hospitals three principal grades, an ordinary, middle, and low, besides minor varieties. These are again divided, in the same manner as the soldiers' daily rations, into meat and fast-day diets. The former in its ordinary form consists of 409 grammes of meat, 819 grammes of rye bread with groats, sauerkraut, dried vegetables, &c., as well as 1·23 litre of kwass

[1] S. Kirchner; also F. Renk, *Ueber die Kost im Krankenhause zu München.*
[2] From Roth and Lex, op. cit.

(rye beer); the middle of 205 grammes of meat, 613 of white bread, vegetables, and condiments; the low of 205 to 409 grammes of white bread, milk, tea, sugar, dried fruit, &c., but no meat. The ordinary fast-day ration closely resembles that of the healthy soldier, but includes only 819 grammes of rye bread besides 1·23 litre of kwass, and groats for breakfast. The middle allows for dinner and supper a porridge with fish or mushrooms, and 409 grammes of white bread; the low, tea with sugar for breakfast, oatmeal gruel with honey or oil for dinner and supper, and 209 grammes of white bread.

Sigrist[1] examined the diet in the clinical wards of the Military Hospital at St. Petersburg, and obtained the following results :—

	Albumen	Fat	Carbohydrates	Extra-fine Bread
Ordinary Rations:				
1st	99·9	133·3	371·4	—
2nd	101·6	35·4	446·9	—
,, ...	98·1	34·2	413·0	—
Middle ration . . .	68·1	8·2	446·9	—
,, ,, . . .	65·2	7·1	413·0	—
Extraordinary Rations:				—
Kisell (red groats) . .	1·2	—	135·2	217
Milk	27·4	18·5	59·6	388
,, gruel . . .	12·0	10·9	101·1	315
Fish soup	18·1	2·0	14·1	290
Oatmeal porridge . .	1·3	—	34·9	210

A thorough examination of the diet of the patients in the city hospital at Munich was carried out by F. Renk. The various diets are arranged in the table on the opposite page.

The five grades may be further varied by making use of the choice of foods given under each head, thus :—

1. Ordinary diet and milk diet.
2. Quarter diet, and again with either milk or light puddings, egg, or fruit, either fresh or stewed.
3. Half diet. Morning with milk, or half diet hash, or

[1] Sigrist, 'Analyse der den kranken Soldaten im klin. Militärhospital verabfolgten Nahrung,' *Petersburg. med. Wochenschrift*, No. 22, 1880, from Virchow-Hirsch, *Jahresber. f.* 1880, vol. i.

farinaceous, or milk foods, or half diet with extras for supper.

4. Three-quarter diet with veal or beef.
5. Full diet, and again either with meat or farinaceous or milk foods.

Time	Low Diet	Quarter Diet	Half Diet	Three-quarter Diet	Full Diet
Morning	Coffee ¼ L., with sugar 15 grms., or broth with sippets, or thick soup, or milk, of each ¼ L.	Coffee ¼ L., with sugar 15 grms., and roll, or milk ¼ L. with roll, or broth ¼ L.	The same as in last	The same as in last	The same as in last
Noon	Plain broth ¼ L., or with sippets, or plain thick soup, or Custards, or Panadel soup, or milk, of each ¼ L.	Soup as ordered, or sauce, or stewed fruits, or milk, of each ¼ L. with roll	Soup as ordered ¼ L. Veal 100 grms. stewed, in sauce, roast, or farinaceous food, or milk food with roll	Soup as ordered ¼ L. Beef 96 grms. with vegetables ¼ L., or roast veal 100 grms., or stewed or in broth with roll	Soup as ordered ¼ L Beef 150 grms. with vegetables ¼ L., or farinaceous food, or milk food with roll
Evening	The same as at noon	Broth or milk soup with roll	Soup as ordered ¼ L., or roast veal 70 grms. on 2 days, veal broth ¼ L. on 3, and milk food on 2 days with roll	The same as in half diet	Soup as ordered ¼ L., with roast veal 100 grms. on 2 days, stewed or minced veal 100 grms. on 3 days, and milk food on 2 days with roll

Besides these there are other extras, as ham, butter, cheese, herrings, eggs, bread, milk, tea, and coffee for supper. Beer may be allowed to the extent of ¼–1 litre. Wine, on the other hand, is not included in the diet list, and can be ordered only as a medicine. The several diets are further varied by a daily change in the soup, vegetables, farinaceous and milk foods, and in the cooking of the meat.

To obtain the relative nutritive value of the different diets Renk ascertained on the one hand the average weight of the rations and the mean percentage of dry matters in each, on the other hand the quantity of raw materials which were used for a given number of rations. Comparing these he arrived at the results shown in the following table:—

	Albumen	Fat	Carbohydrates
Coffee with milk and sugar	4·1	3·9	19·2
One roll (50 grms.)	4·8	0·5	30·0
250 ccm. milk	10·2	9·7	10·5
Coffee and roll	8·9	4·4	49·2
Milk ,,	15·0	10·2	40·5
Maccaroni soup	2·9	4·2	13·2
Rice soup	2·0	1·0	19·0
Panadel soup	3·9	4·0	19·0
Semolina soup	2·5	3·6	11·6
Egg and barley soup	3·3	4·0	17·7
Sago soup	0·8	4·8	16·4
Custard	3·4	5·7	4·3
Pearl barley soup	2·8	2·8	17·9
Savoy soup	2·2	5·8	10·4
,, ,, with toasted sippets	4·8	6·1	27·0
Plain broth	0·0	0·2	0·0
As cooked for table: Spinach	4·8	14·2	18·0
Blue cabbage	3·8	14·5	21·2
White ,,	3·7	11·7	20·0
Savoy	3·6	12·6	18·7
Kohl rabi	3·8	12·7	23·8
Erddotschen[1]	3·7	14·5	29·6
Carrots	3·3	18·1	24·5
Turnips	3·3	17·0	24·2
Potatoes	5·1	8·8	68·2
Peas	13·2	13·4	36·3
Beans	14·7	11·5	40·5
Lentils	15·2	14·0	34·5
Baked dumplings 1 ration	22·3	33·9	87·0
,, ,, ½ ration	15·2	22·6	58·0
Light pudding	12·1	8·7	22·0
Bread dumpling	15·5	39·3	64·7
Flour ,,	23·9	43·7	76·0
Semolina ,,	20·1	38·5	74·9
Bread maccaroni	17·3	38·1	48·6
Vermicelli	18·0	19·7	55·9
Apple jam	0·2	0·0	26·2
Quince ,,	0·6	0·0	57·4
Rice boiled in milk	13·6	9·8	41·7
Semolina ,, ,,	9·2	7·6	24·6
Flour ,, ,,	15·4	12·4	30·7
Maccaroni ,, ,,	16·5	9·4	31·0
Beef, ¾ diet with fat	26·5	16·2	0·0
,, full ,, ,, ,,	38·9	18·0	0·0
Broth	2·0	11·9	11·9
Brain sauce and prepared veal	1·0	6·0	6·0
Stewed veal with fat and sauce	20·5	15·3	9·1
Roast veal with sauce, for dinner	31·8	6·7	4·1
,, ,, ,, ,, ,, supper	16·4	4·7	4·1
Hash with two dumplings	16·9	13·1	20·0
Two dumplings	2·1	3·5	6·3

[1] [Erddotschen I believe to be a variety of kohl rabi, the bulbous enlargement of which is underground, whereas that of the kohl rabi proper is above.—TRANSLATOR.]

The mean nutritive value of the individual dishes is seen from the following tables:—

		Albumen	Fat	Carbohydrates
I. Diet	a. Ordinary	4·6	2·7	26·2
	b. With milk	30·6	29·1	31·5
II. Quarter diet	a. Ordinary	37·5	25·8	150·3
	b. With light puddings	32·8	22·1	130·5
	c. " fruit	25·9	13·9	178·0
	d. " batter ? (*Mus*)	39·5	26·3	169·2
	e. " egg	20·3	17·7	23·5
III. Half diet	a. Ordinary	47·9	25·1	145·2
	b. With milk	53·9	30·9	136·5
	c " *hachée*	41·0	28·4	157·6
	d. " farinaceous foods	36·7	33·6	178·8
	e. With milk foods	33·6	19·3	159·7
	f. " the evening extras	55·6	33·3	157·8
IV. Three-quarter diet	a. Beef	63·0	48·2	175·1
	b. Veal	55·2	33·2	162·6
V. Full diet	a. Ordinary	92·9	53·6	183·3
	b. With farinaceous food	58·3	68·8	254·6
	c. With milk foods	48·1	31·3	198·5
	Drinks.			
	1 litre beer	—	—	56·0
	½ litre milk	20·4	19·4	21·0
	Extras.			
	1 ration of coffee	4·1	3·9	19·2
	100 grms. ham	30·0	32·0	—
	100 " butter	0·3	86·7	—
	100 " cheese	32·0	25·0	—
	1 egg	6·3	4·9	—
	1 roll	4·8	0·5	30·0

The full diet is especially intended for those whose general utrition does not differ in any degree from that of health, and hose requirements in respect of the several aliments are the ıme as those of healthy men not performing any work.

For the dieting of such persons we may make use, without any ualification, of the knowledge we possess of the needs of the normal uman organism under various conditions, so that we are in a position › apply a critical standard to the dietaries in question. In the ›inion of Voit the diet of a prisoner not employed in labour should ›ntain 85 grammes of albumen, 30 grammes of fat, and 300 grammes carbohydrates. Although these amounts are, for reasons already ven, quite insufficient to maintain a powerful labourer under sustined exertion, they may well suffice to prevent any great loss of ıbstance even in well-nourished individuals.

The ordinary full diet in the Munich Hospital contains albumen (93 grammes) and fat (54 grammes) in due proportion, but the amount of carbohydrates (195 grammes) is too small. This defect is partly compensated for by the allowance of beer, usually of 540 ccm., containing 28 grammes of carbohydrates. But even then these reach only 211 grammes per day, so that Renk has very properly recommended that the bread ration should be raised from 150 to 250 grammes, which would give a total of albumen 103 grammes, fat 54 grammes, and carbohydrates 271 grammes. At present this additional bread can only be ordered as an extra; further than this extras are only exceptionally prescribed in full diet.

Full diet is also as a rule prescribed for those patients in whom an improved state of nutrition or increase of substance is desired, assuming that they are in a condition to partake of ordinary mixed food without injury to their digestive organs, as is often the case with patients in advanced stages of convalescence.

For this purpose full diet with milk or farinaceous foods is most adapted, and it is frequently given at the express wish of the patients themselves.

Three-quarter diet is ordered in place of the full diet in a large number of such cases, especially among female patients, but for this purpose it does not appear sufficient unless supplemented by extras. Three-quarter diet serves also as a transitional step to the full diet with convalescents, who are first allowed veal, which is considered lighter and more digestible than boiled beef and vegetables. In this diet beer, milk frequently, bacon, and eggs are added as extras if the condition of the patient is to be improved, but the full diet do not seem expedient on account of the state of the digestive organs.

Three-quarter diet with beef and the average allowance of beer (390 ccm.) contains, according to Renk, 63 grammes of albumen, 48 grammes of fat, and 195 grammes of carbohydrates, far less than Forster found in the diet of the old ladies in the asylum for clergymen's widows. It can consequently furnish a subsistence diet even for female patients only by the addition of 100 grammes of white bread, bringing the proportions up to albumen 73 grammes, fat 48 grammes, and carbohydrates 255 grammes daily.

Half diet is, as already stated, divisible into six varieties, and with the addition of veal and of extras at supper it forms the transition to the three-quarter veal diet. This diet is chiefly

employed in the treatment of patients who are able to take solid food, but whose digestion is still so weak as to need caution as regards the quantity. By changing the soup and by alternating the mode of cooking the veal, giving it roast on Sunday and Thursday, *eingemacht* on Monday, Wednesday, and Saturday, and stewed on Tuesday and Friday, a certain variety is introduced into the half diet. Extras too are very largely ordered with this diet.

Half diet with milk differs from the ordinary half diet in the substitution of $\frac{1}{4}$ litre of milk with roll for the usual coffee and roll. Half diet with mince (*hachée*), this diet being given in place of veal, and with finely sliced ham, forms a frequent transition from liquid to solid foods. Half diet is therefore in great request, and under these circumstances is often prescribed with milk foods when bread and milk, and rice, flour, semolina, vermicelli, &c., in milk in the forms of gruel, porridge or pudding are substituted for the veal. Half diet with farinaceous foods is rarely ordered, since the various forms of boiled or baked dumplings, &c., which come under this head, are considered less fit for weak digestions.[1]

[1] [I have given a free rendering of this paragraph, since several of the terms employed have no precise equivalents in English. But, for the benefit of those readers who may have occasion to refer to German works on dietaries, I may here give a few general definitions. *Brei* corresponds to our porridge, when made with coarse oatmeal, wheaten groats or hominy, and to our pease pudding, or 'pease brose' as it is called in Scotland, when the material is pease or lentils. *Mus* by itself is an equivocal and untranslatable term, being applied to almost anything boiled down to a soft mass. Thus Reismus and Griesmus nearly correspond to blanc-manges; Mehlmus (probably intended in this passage) to batter-pudding; Apfelmus is what we call apple sauce; Semmelmus is like our bread sauce; and Rhabarbemus is stewed rhubarb. *Schleim*, as the word implies, is any starchy food, as rice, sago, pearl barley &c., boiled to a thick glairy consistence; thus Gersteschleim and Gerstewasser are thick and thin barley-water respectively. *Auflauf* is a very wide expression, comprising all sorts of light puddings. *Nudel* in like manner includes maccaroni and vermicelli imported and home-made, and also several baked or boiled dumplings &c., made with flour, white bread crumbs &c. (Dampfnudeln). The nearest equivalent of our light dumplings is *Knödel*; and *Schmarren*, which also occurs in the text, is a local South-German word of the same meaning. *Suppe* is of a far wider significance than our soup, being used in German, as in English formerly, of nearly all fluid or semifluid foods taken with a spoon, and thus including, for example, bread and milk, thin custards, &c. Lastly, *Brod* usually refers to rye-bread, or at any rate to the coarser browner kinds. In Germany fine white wheaten flour is mostly employed for what we call

Quarter diet with or without eggs is especially employed in acute febrile conditions, when care must be taken from the first to keep up the strength. In this diet form neither meat nor bread is given, but it contains in the forms of custards and the like, albumen 20·3 grammes, fat 17·7 grammes, and carbohydrates 23·5 grammes, while half a litre of milk, containing albumen 20·4 grammes, fat 19·4 grammes, and carbohydrates 21 grammes, and one or even two eggs, each egg = albumen 6·3 grammes and fat 4·9 grammes—are frequently added as extras. The other forms of quarter diet are given in milder febrile states and in the first period of defervescence, as well as to patients whose digestive powers appear to be greatly enfeebled, from whatever cause. Quarter diet with *Mus*[1] (the average ration consisting of 22½ grammes of meal, 312 ccm. of milk, and 1 gramme of sugar, = 15·4 grammes of albumen, 12·4 grammes of fat, and 30·7 grammes of carbohydrates) is a great favourite with the physicians.

Low diet is only prescribed in a few cases of greatly impaired digestive powers; it is properly a diet of abstinence or starvation diet, since it contains only 4·1 grammes of albumen, 4·3 grammes of fat, and 19·2 grammes of carbohydrates. Milk diet, on the other hand, has aims and uses of a very different character; in it a quarter of a litre of milk is given thrice daily, or in all albumen 30·6, fat 29·1, and carbohydrates 31·5 (see on Milk Cures).

There is a great similarity between the dietaries of the Munich General Hospital and the City Hospital at Augsburg.[2] In the latter there are four grades of diet, with the following composition as regards the aliment:—

	Albumen	Fat	Carbohydrates
Low diet	7 grms.	25 grms.	39 grms.
Quarter diet . . .	26 ,,	34 ,,	95 ,,
Half ,, ...	75 ,,	57 ,,	207 ,,
Full ,, ...	94 ,,	57 ,,	226 ,,

The kind and quantity of the food given of each meal in the several grades is shown in the following tables.

French or Vienna rolls. These are called *Semmel* in South Germany and *Wecken* in the North. Bauer always uses the former term. TRANSLATOR.]

[1] See note on preceding page.

[2] Collected from the works of Renk.

		Weight of Each Ration	Water	Albumen	Fat	Carbo-hydrates
I. *Low Diet.*						
Morning, Noon, Evening	Broth with sippets or thick soup .	840	769·1	7·2	25·2	38·5
II. *Quarter Diet.*						
Morning	Beef tea or broth with sippets .	280	256·2	2·6	8·4	12·8
Noon	Soup made with rice, barley (Eiergerste), groats, sago, macaroni, potatoes, white bread, brown bread, panada or vegetables .	280	243·0	4·6	8·4	24·0
	Extras: two light-boiled eggs, rice, or semolina in milk, bread or macaroni dumplings, stewed veal, stewed lung, hachée, calf's foot, with gravy .	105	50·6	10·8	8·6	12·0
Evening	Soup as above .	280	243·0	4·6	8·4	24·0
	White bread for the day . .	35	9·9	3·4	—	21·7
		980	802·7	26·0	33·8	94·5
III. *Half Diet.*						
Morning	Beef tea, milk, or broth . .	420	383·5	4·0	12·5	20·0
Noon	Ditto . . .	420	363·5	7·5	13·0	36·0
	Beef . . .	140	106·2	30·7	1·3	—
	Vegetables: turnips, carrots, potatoes, kohl rabi, savoy, spinach, broccoli, sauerkraut, greens, beans, or peas . .	210	152·0	4·6	8·2	38·0
Evening	Soup as above .	420	364·5	7·5	13·0	36·0
	Extras: as in Quarter Diet at Noon . .	105	50·6	10·8	8·6	12·0
	Bread for the day . . .	105	29·6	10·2	—	65·0
		1820	1449·9	75·3	56·6	207·0

	Weight of Each Ration	Water	Albumen	Fat	Carbo-hydrates
IV. *Full Diet.*					
Morning { Soup as in Half Diet . .	420	382·2	4·0	12·5	20·0
Noon { Soup as above .	420	263·5	7·5	13·0	36·0
Beef . . .	210	152·0	45·9	1·9	—
Vegetables as above . .	210	152·0	4·6	8·2	38·0
Evening { Soup as above .	420	362·5	7·3	13·0	36·0
Extras: as in Half Diet .	105	50·6	10·8	8·6	12·0
Bread for the day. . .	140	40·0	13·4	—	84·1
	1925	1510·0	93·5	57·2	226·1

By special order the following extras may be given in any of the above diets:—

	Weight of a Ration	Water	Albumen	Fat	Carbo-hydrates
White bread . . .	70	21·3	6·7	—	41·5
Black „ . . .	140	64·8	11·6	—	61·8
Meat	140	109·2	21·5	7·3	—
Fruit	140	90·0	—	—	50·0
Flour, rice or semolina, in milk	240	157·7	11·8	7·8	8·5
Broth with egg . . .	240	220·5	6·5	8·0	3·0
Milk	240	210·0	9·8	9·3	10·0
Chocolate with milk . .	180	168·7	6·7	6·6	7·0
Coffee	180	168·0	3·0	4·0	3·0
Wine soup and egg . .	180	162·0	6·5	5·0	6·5
White beer	500	478·0	—	—	17·5
Brown „	500	472·8	—	—	22·8
Warm beer with egg . .	240	220·0	6·5	5·0	8·4
Sugar water . . .	35	—	—	—	35·0
One egg	46·5	34·4	6·5	5·0	—

In the hospital at Schwerin there are also four diets, which, as estimated by F. Müller, contain the following proportion of the aliments:—

	Albumen	Fat	Carbohydrates
1st diet form . . .	83 grms.	62 grms.	405 grms.
2nd „ „	76 „	53 „	392 „
3rd „ „	67 „	69 „	259 „
4th „ „	43 „	18 „	164 „

The arrangement of these diets is as follows:—

		I.	II.	III.	IV.
1. Breakfast	Coffee	8	8	—	—
	Sugar	8	8	—	—
	Milk	125	125	500	250
	White bread	80	80	80	80
2. Breakfast	Black „	80	White bread 80	80	Meal for soup 80
	Butter	25	20	20	—
Dinner five times a week	Raw meat	250	166	Broth ?	—
	Potatoes	690	518	White bread 80	40
	Meal for soup	40	40	40	40
	Butter	5	5	5	—
Dinner twice a week	Milk for soup	125	125	Broth ?	—
	Meal „	40	40	40	40
	Butter „	8	8	5	—
	Potatoes	690	518	White bread 80	White bread 40
Evening	Coffee	8	8	—	—
	Sugar	8	8	—	—
	Milk	125	125	250	250
	White bread	80	80	40	20
Supper	Meal for soup	40	40	40	40
	Black bread	80	80	White bread 80	White bread 40
	Butter	25	20	20	—[1]

The Society of Public Health at Halle had analyses made of the first diet form in the city hospital and in the infirmary wards of the House of Correction. The following means were obtained:—

	Albumen	Fat	Carbohydrates
Hospital	92 grms.	30 grms.	393 grms.
House of Correction, with brown bread	96 „	26 „	515 „
House of Correction, with white bread	60 „	26 „	337 „

From the more minute examination of the diet in different hospitals[2] one may gather what amount of food stuffs is provided in each grade of dietary and how far they constitute an adequate diet for an adult man or must lead to an ultimate loss of body-

[1] From F. Renk and others.

[2] In the year 1880 such an enquiry into the dietary of the Children's Hospital at Nürnberg, conducted by Dr. Cnopf, physician to the institution, was published in the *Transactions of the Society of Public Health* of that city; but, since in the present treatise all calculations are made for grown persons, we do not think it necessary to reproduce it.

Further details as to the several dietaries prescribed in the different hospitals, without more exact statements of the quantity of each foodstuff contained therein, would be of no special value; one can at most learn from them what kinds of food and modes of preparation are employed in various places in the nutrition of the sick. I refer here to the reports of several hospitals, but especially to that by P. Squire, *The Pharmacopœias of Twenty-five of the London Hospitals* (London, 1879), as well as to the English Blue Book of the year 1866, 'Dietaries for the Inmates of Workhouses, &c.,' by Dr. Ed. Smith.

weight. Formerly there existed only general statements, from which it also appeared that in dietetic prescriptions the quality alone was indicated, but the quantity was not regulated by any exact methods.[1]

In determining the several dietaries to be adopted in hospitals generally the mean requirements of the healthy man obviously suggest a maximum standard on which to calculate the full diet, by a corresponding reduction of which the half diet, quarter diet, &c., are to be graduated. These several steps in reduction must take account in the first place of the functional capabilities of the digestive organs, and provision should be made for replacing the waste of the organism by the administration of such food as the condition of the digestive organs for the time being may permit. The lower the digestive powers are reduced the more necessary is it to supply such nourishment only as can easily be absorbed with the stream of nutrient juices. In most of the lower dietaries no special regard is paid to the particular proportion of albumen, fat, and carbohydrates, and if in many cases this seems very different from that of normal nutrition it will be probably found to be a mere accident, from which we may infer no more than that the aim was to provide the most easily assimilated nourishment without reference to the proportions in which the food stuffs were combined.

Of late years the attempt has been made to turn to therapeutical account the different actions of the several foodstuffs; to give, for example, with a special aim in view a highly albuminous diet in one case and one poor in albuminates in another. If, however, separate dietaries had to be drawn up for each of these the list would become so great as to render the care of large numbers of the sick extremely arduous. To avoid this it has been the custom in nearly all hospitals to allow of 'extras' being ordered, so as to give the physician free play to effect any desired combination of foodstuffs.

[1] To enable physicians to combine in particular dietetic prescriptions a due exhibition of the quantities of albumen, fat, and carbohydrates in the several foods administered, Chr. Jürgensen stated the proportion of each aliment in several fluid forms of nourishment. The calculation of the foodstuffs was based partly on specially conducted analyses and partly on the mean values assigned by J. König to the raw materials employed (*Hospitals-Tidende*, 1879, quoted by Virchow and Hirsch, *Jahresbericht* for 1879).

Unfortunately, as we have repeatedly said, we are often not in a position to state with any precision how much of each of these is available in a given arrangement of food. Meanwhile the physiological value of each must not be neglected—advice which needs to be insisted on, since many erroneous notions handed down from former times still exert a certain influence.

It is obvious that a distribution of the daily food over several meals is still more necessary with the sick than with those in robust health, since a single overloading of digestive organs already debilitated would be productive of far graver consequences than it would were they in a normal condition. Experience has in this respect long since proved that in cases of feeble digestion food is much better taken in small quantities at short intervals, and that under certain circumstances it is best to abstain altogether from any regular meal times.

In the General Hospital of Munich breakfast is taken at six o'clock in the morning, dinner at eleven, and the evening meal at five. Such a distribution of the meal times would indeed be quite impracticable in everyday life, but for the sick I am decidedly of opinion that it is the best.

The question of how much food should be administered is doubtless one of great importance, but in many cases it falls into the background before the necessity of contemplating the diet in the first place as regards its quality, and of selecting such foods as shall be most easily assimilated under any given circumstances. Physicians in all ages have rightly laid great weight on the choice of foods for the sick. The results of experience on the digestibility of foods and the best modes of cooking them under different circumstances, which have been handed down from the earliest ages, must be carefully estimated in the light of individual circumstances. One must not forget that a food which is not properly digested may seriously injure the organism. The lower the activity of the digestive organs is reduced the more caution is required, and the less will be the number of foods the administration of which can be entertained. At the same time we must, under particular circumstances, have recourse to other foods that the healthy individual never employs, as cod-liver oil, meat juice, solution of peptone, &c.

Condiments and flavourings have a still greater value in the nutrition of the sick than of the sound; but in this connection it is obvious that more importance must be attached to tasty and tempting modes of cooking, the free use of pungent and highly stimulating condiments being as a rule inadmissible. How important it is that one should set before the sick man with no relish for food something that is particularly pleasing to his taste is a matter of daily experience; indeed, one may often see that while ordinary foods are rejected with disgust, or even vomited after having been taken, some favourite dish or dainty morsel is eaten with zest and easily retained. Many things that in daily life we are accustomed to look on as mere luxuries become most useful, if not indispensable in the invalid kitchen. But a certain variety and multiplicity of gustatory impressions is not less needed in sickness than in health, and one may often observe how, in consequence of a too monotonous diet, the appetite disappears and a positive repugnance to all food succeeds. It is, however, sometimes very difficult to satisfy these demands—when, for example, only fluid foods can be administered—and, again, many a good intention of providing the patient with a prescribed quantity of each aliment is defeated by the repugnance created in the patient by neglect of the necessary conditions of flavour and variety.

Certain foods to which an agreeable taste can in no way be imparted, but which possess a special value in the nutrition of the sick on account of the form in which their constituent aliments are present, are best given as medicines, something being taken afterwards to efface the taste.

The most useful of the stimulants, &c., for the sick are undoubtedly beef tea, tea, coffee, and alcohol. The high value of these in the nutrition of the sick is not lessened by the knowledge that without some further addition they cannot serve as food, for their influence on certain functions of the nervous system is far more important than the mere taking of food. One need not have any doubt as to the respective aims in view in the administering of stimulants and relishes on the one hand and of foods proper on the other when one reflects that the former supply no materials for the processes of metabolism, but simply serve to utilise to the utmost the vital forces present.

SPECIAL DIETETICS FOR THE SICK.

ADMINISTRATION OF FOOD IN FEBRILE STATES.

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It is an undisputed fact that the diet of fever patients calls for great caution, since any large amount of solid food is ill-borne and may indeed lead to serious consequences. The fact that in most febrile diseases the desire for food is greatly lessened, if not entirely lost, is enough to prove that the febrile process is attended by abnormal conditions of the animal economy manifesting themselves especially in a lessened activity of the digestive organs. It is therefore not to be wondered at that the overwhelming majority of physicians in all ages have held the opinion that in febrile states generally a restricted diet is indicated. At the same time the more thoughtful observers among them have always held that an extreme withholding of food was justifiable only under special circumstances, since as a rule a too rigid abstinence must be deprecated, especially in fevers of long duration, as accelerating the failure of strength. A really judicious fever diet, taking account on the one hand of the enfeebled digestion and on the other of the maintenance of the strength, has from the earliest times been a desideratum in the successful treatment of these diseases.

Hippokrates, whose dietetic maxims for the treatment of fevers have always held their ground, although from time to time one-sided systematics have promulgated contrary doctrines, cannot with any justice be claimed as a supporter by those physicians who would prescribe a rigid abstinence in acute febrile diseases. Without by any means excluding other nourishment the well-known decoction of barley plays a leading part in the Hippokratic rules for the treatment of acute fevers. The strength of the patient was the chief indication for the administration of food; the stage of the disease and the intensity of the symptoms were to be anxiously watched; and in the height of the fever the sparest diet was prescribed.[1]

[1] See J. F. K. Hecker, *Gesch. d. Heilkunde*, vol. i. p. 151.

Although the majority of physicians have always held by the practice of moderation based on the results of experience, there have not been wanting at times those who advocated extreme views and expected benefit only from a highly nutritious or from an excessively sparing diet. It is certain that most of these extravagances were suggested by particular theoretical notions as to the origin and nature of fevers, foremost among which the doctrine that fevers and inflammations drew fresh strength from each accession of nourishment suggested those systems of abstinence which denied the fever patient all nourishing food for weeks together. One might almost come to the conclusion that in the treatment of febrile states it would be most prudent to follow Hippokrates implicitly and to refrain from all further enquiries, since we seem thereby to incur repeated risks of falling into error. But such a course would preclude all further progress, whereas there are at the present moment questions of the highest importance from a practical standpoint awaiting solution. Yet scientific enquiry does not feel itself called on to throw overboard the results of a thousand years' experience and to start afresh from immature conclusions; much rather would it build on the foundations ready to hand.

In a scientific examination of the question by what principles to regulate the administration of food in fevers we must first of all keep in view the nature of the losses suffered by the organism in the course of the febrile processes, and what consequences as regards either the constitution or function of the organs most essential to life will accrue if no reparation be effected. Next we should enquire what effect the administration of the several foodstuffs has on the one hand on the consumption of material in the body, and on the other on the activity and functional energy of the organs, and above all on the fever itself—that is, on the height to which the temperature rises. Lastly, it is necessary to recognise accurately the functional disturbances undergone by the digestive organs, and to infer from thence what foodstuffs may under the given conditions be taken into the nutrient currents, and in what forms, so as not to further injure the digestive apparatus and through it the system generally. How far our actual materials enable

us rightly to estimate these at any particular moment the following survey of the subject must show, but I think it my duty to insist emphatically on the gaps in our positive knowledge.

The Consumption of the Materials of the Body as a Consequence of Febrile Disease.

The marked emaciation which as a rule accompanies febrile processes—those at least of any long duration—was in the earliest ages referred to the fever itself. But later, when the notion that fever was a beneficent effort of nature gained ground among physicians, the waste of the body in the course of febrile diseases was brought into connection with various and altogether different causes, while a directly conservative action was ascribed to the fever. Only quite recently has it been definitively established that as a matter of fact every febrile state involves an increased consumption of the materials of the body.

From numerous weighings of fever patients, systematically carried out by several observers, it is clear that in the course of the febrile process the weight of the body as a rule undergoes a considerable reduction. From this fact alone we should, however, be by no means justified in assuming an increased consumption of body-substance, since the loss of weight might very possibly be due solely to the insufficient supply of nourishment. This circumstance has been very properly borne in mind by most observers who have conducted such weighings of fever patients, but it is extremely difficult to decide how much of the loss of substance that makes itself apparent in the course of a febrile attack is to be put down to the account of a partial inanition and how much to that of the disease. A comparison has indeed been made of the change of body-weight undergone by a healthy man when he received only the same nourishment as the sick. But in all such comparisons we must bear in mind that, as we have already seen, the material effects of a given weight of any kind of food are to a great extent dependent on the state of nutrition of the

organism at the time, so that a well-nourished individual might suffer considerable loss of weight on the same diet on which an ill-nourished or reduced one would gain flesh. On these grounds a few isolated estimates of the body-weight in the healthy and the sick cannot be taken as sufficient; but, in view of the pretty large experience that we already possess on this subject, no one will seriously contest the position that the loss of body-weight in the course of febrile diseases is only in part explicable by the insufficient diet, and that it is in part to be referred to the disease itself. This agrees with the observation that many fever patients continue to lose weight, and may be reduced to an extreme degree of emaciation, although they continue to take a very fair amount of nourishment. Nevertheless in this direction also more exact enquiries are necessary, since it is not as yet known what proportion of the nourishment taken is utilised in the digestive canal.

The loss of weight in the course of febrile disease is by no means a correct measure of the actual loss of substance which the body has suffered, since the quantity of water present in the organs and tissues is subject to great variations. In the opinion of Leyden,[1] it is very probable that during the height of the fever a retention of water in the tissues actually takes place, and from other observations it appears that the proportion of water in the body generally stands in direct and intimate relation with the state of its nutrition. It may, then, frequently happen that a man has lost far more albumen and fat than one could calculate from the loss of body-weight, unless one were in a position to obtain more precise information as to the changes in the proportion of water in the organs.[2]

I am far from depreciating the value of weighings of the body in disease, in so far as they deal with wide variations of the body-weight; but it would be an error to draw any conclusion as to the intensity of the febrile consumption, or to seek to measure by its means what further influence it may exert on the functions of the more important organs. According to Liebermeister the share in which the various

[1] E. Leyden, 'Untersuchungen über das Fieber,' *Arch. f. klin. Med.*, vol. v. 1869.

[2] For an exhaustive treatment of the change of weight in febrile diseases see, besides the authorities cited in the text, Liebermeister, *Pathologie und Therapie des Fiebers.*

organs suffer consumption is probably different from what is seen in simple inanition, since in chronic fevers the mass of the blood seems to be more quickly wasted than the other tissues.

To the rule that in the course of febrile diseases the body-weight suffers a more or less important reduction there are occasional exceptions in which, notwithstanding prolonged pyrexia, the weight of the body remains constant or even increases. This occurs with the greatest relative frequency in chronic diseases attended with moderate and remittent pyrexia, as phthisis. Quite recently, however, Uffelmann has described cases of acute febrile disease in the course of which the originally reduced body-weight had subsequently risen, although the fever continued throughout.[1]

Most startling is the observation of Uffelmann of a gastrotomised boy $7\frac{3}{4}$ years old, in whom febrile symptoms commenced immediately after the operation and continued for twelve weeks. The patient, who at the time of the operation weighed 16·5 kilos., gained in the above-mentioned time 2,880 grammes in weight. Meanwhile his general appearance improved and his previously reduced muscular strength returned, whence one may safely conclude that the gain of weight did not consist in a disproportionate increase of the water in the tissues.

Genzmer and Volkmann, too, in their valuable observations on septic and aseptic fevers, record cases of the latter in which, although the fever lasted for eight, ten, or even fourteen days, no perceptible reduction of body-weight or muscular strength ensued.[2]

It is therefore clear that a fevered organism, just as a normal one, can maintain its material equilibrium, or actually add to its substance, if the assimilation of nutriment equal or exceed the waste of the body. But several reasons may be adduced in answer to the question why the conditions for the replacement of body-substance are frequently present in chronic, but never, or at least only exceptionally, in acute febrile

[1] J. Uffelmann, 'Ueber Gewichtszunahme im Fieber,' *Zeitschr. f. pract. Med.*, 1877, No. 44 ; also, 'Ueber Ernährungs- und Gewichtsverhältnisse eines fiebernden Säuglings,' *Deutsch. med. Wochenschrift*, 1879, Nos. 31 and 32.

[2] A. Genzmer and R. Volkmann, 'Ueber septisches und aseptisches Wundfieber,' *Samml. klin. Vorträge v. R. Volkmann*, No. 121, 1877.

processes. Liebermeister has laid stress on the fact that in the first place remissions and intermissions, which frequently occur in chronic forms of fever, induce a less waste than a continuous high pyrexia. Again, in chronic fevers one has as a rule to do with persons who are already more or less wasted and reduced by long previous illness, and in whom, therefore, a relatively smaller amount of nourishment is capable of compensating, or even of more than compensating, for the loss. But in the opinion of Uffelmann the impossibility of preventing the waste of body substance in acute and intense febrile states is due especially to the digestive powers being so seriously impaired as to be unable to keep pace with the destruction of the tissues. But, if in any individual patient there should be no such grave disturbance of the digestive apparatus as to disable it from assimilating the amount of nourishment demanded under the circumstances, the body may maintain its normal state, and under certain conditions even take on flesh. In chronic fevers, as also in the later stages of febrile diseases, if decided remissions or complete intermissions supervene, a partial restoration of the digestive power is often observed, and this, according to Uffelmann, is the chief reason why in such patients an increase of weight may be attained with comparative frequency. (Compare the following chapter on the Effects of Food in Fever.)

The fact that no considerable increase of body weight occurs in the majority of fever cases, and which finds only a partial explanation in the insufficient supply of nourishment, proves with absolute certainty that an abnormal augmentation of the metabolic processes follows as a direct consequence of the fever itself. This conclusion has been fully confirmed by numerous estimates of the products of metabolism in fever patients, and it has thus become possible to approach the question of the proportion in which the several constituents of the body share in the general increase of the waste. It is, for example, essential to a correct estimate of the signification and extent of the febrile consumption not merely to know the total amount of the general loss which the body of a fever patient experiences in a given time, but also in what propor-

tions the principal constituents partake in the general metabolism.

That in every case of fever there is an increase of albuminous metabolism all observations testify. The quantity of nitrogenous waste products excreted by a febrile patient in the course of twenty-four hours may vary between wide limits, but it has been found that under all conditions a febrile organism metabolises more albumen than a non-febrile one under the like circumstances. It may even happen that the excretion of urea by a fever patient will, notwithstanding the most restricted diet or even absolute deprivation of nutriment, exceed by 40 to 50 grammes that of a healthy man indulging in an ample amount of food. In many other cases, however, the excretion of nitrogenous waste products in the urine would seem to be increased only in proportion to the supply of food and the store of albumen in the body.

From the information we already possess we may conclude that the extent of the metabolism of albumen in a febrile subject is determined by a number of factors, some corresponding to physiological conditions but others referable only to pathological processes. Among the former we may specially mention the assumption of nutriment and the proportion of fat and albumen in the body. Thus the higher average excretion of nitrogenous waste products at the commencement of a fever is doubtless due to the fact that in the early stage of the disease the body is as a rule in a good state of nutrition.

One might well assume *a priori* that the store of fat in the tissues would have an influence on albuminous metabolism in fever as in health. But at the same time we must take into account the observation made by Voit on fasting animals, that an increased consumption of albumen followed the exhaustion of the fat present in the body. If the same occur in fevers after the greater part of the animal fat is used up there would in the advanced stage of emaciation be a great increase of albuminous metabolism, which could not fail to be of serious import to such patients.

An excessive accumulation of fat is decidedly unfavourable in febrile diseases, a fact which, according to Liebermeister, may be referred to several causes—first, that in very obese subjects the febrile elevation of temperature is prone to rise higher than in

persons with no more than the normal deposits of fat. Besides, the phenomena of cardiac weakness appear earlier in such patients, and the parenchymatous degeneration of the organs, of which we shall speak later, often sets in after a very short period of fever. Those, too, who have been used to alcoholic excess are in the same position.[1]

The researches of Bartels, Naunyn, and Schleich have proved that an elevation of the body temperature, artificially induced by preventing the loss of heat, induces an increased excretion of urea, which may even continue for some time after the temperature of the body has returned to the normal.[2] From these observations we may infer that the albuminous metabolism in fever is also conditioned by the degree to which the temperature rises, and many authorities are indeed inclined to consider it as due solely to the elevation of the body temperature. There are, however, important objections to this hypothesis, and, above all, the observation of Naunyn that after artificially produced septic fever the increased excretion of urea was already demonstrable before the temperature began to rise.[3] So also the elimination of urea and the elevation of temperature in fever do not show any constant parallelism, such as one would expect did no other conditions concur with the increased consumption of albumen.[4] It is not improbable that several of the exciting causes of fever themselves give rise to an increased destruction of albumen, such as is seen in the effects of some poisons. Alterations of structure and derangements of function in other organs, as those of circulation and respiration, may tend in the same direction.[5]

[1] For references to numerous works where may be found statements of the excretion of urea in fever see Liebermeister, *Pathologie und Therapie des Fiebers*, and Senator, *Untersuchungen über den fieberhaften Process*.

[2] Bartels, *Pathol. Untersuch.*, 1861; Naunyn, *Berl. klin. Woch.*, No. 4, 1869, and *Arch. f. Anat. und Phys.*, 1870; G. Schleich, *Arch. f. exper. Path.*, vol. iv.

[3] Naunyn, *Arch. f. Anat. und Phys.*, 1870: Sydney Ringer, *Transact. Med.-Chir. Soc.*, xlii. 1859; Warfwinge, *Hygiea*, 1877, p. 73, and Maly's *Jahresber. für* 1877, p. 247.

[4] See Huppert, 'Ueber die Beziehung der Harnstoffausscheidung zur Körpertemperatur,' *Arch. d. Heilk.*, vii. 1866.

[5] Compare A. Fränkel, *Centralbl. f. d. med. Wissensch.*, 1875, p. 739, and 1877, p. 767; *Arch. f. path. Anat.*, lxvii. and lxx.

From many observations I believe that I may infer that the increase of albuminous metabolism shows certain differences according to the nature of the fever, even when the actual temperature is the same. It is, however, very difficult to adduce a strict proof of these conjectures, since the gain and loss of albumen are dependent not on one but on a multiplicity of conditions, and when a pleuritic patient, e.g., excretes in 24 hours 30 grammes of urea, while one with typhus has eliminated 40 grammes in the same time, it is by no means to be assumed from this fact alone that typhus involves a greater disintegration of the albuminous tissues than pleurisy. A consideration of no small importance as bearing on the question before us occurred to me in the course of some experiments on animals, when a dog with artificially induced septic fever, which ended fatally on the fourth day, excreted considerably more nitrogen in the urine than another in whom severe inflammation with formation of abscesses was set up by subcutaneous injection of croton oil. The elevation of temperature differed little, and previously to the induction of the fever they had, when fasting, excreted almost the same amount of urea.

It would be interesting to follow more accurately the progress of albuminous metabolism in patients with aseptic surgical fever, as observed by Genzmer and Volkmann, since these, exhibiting none of the symptoms of fever except the elevation of temperature, would probably enable us to recognise its effects on the organism independently.

Since the several conditions determining the intensity of albuminous metabolism in fever patients may represent very different values, it is clear that mean numerical statements of the waste of albumen in fevers are of minor significance, and if some authorities have asserted that the excretion of nitrogenous waste products may exceed the normal amount by 70 to 100 per cent., or even more, these figures can obviously have no general value, and merely prove that fever patients suffer as a rule a very considerable and, under certain conditions, an enormous loss of the albuminous constituents of the body.

In many enquiries into the elimination of urea in fever sufficient attention has not been paid to the supply of nourishment, so that it cannot be inferred from the mere amounts of the products of albuminous metabolism how much albumen has been withdrawn from the body itself. A masterly investigation of the gain and loss of

albumen in fever patients was, however, conducted by Huppert and Riesell, and the cases adduced might serve as examples to illustrate the loss of albumen by the organism in febrile diseases.

A patient with croupous pneumonia excreted during a period of five days of high fever 84·47 grammes of nitrogen by the urine and fæces, besides 1·83 contained in the sputa.

Since during this time only 2·95 grammes were taken in with the food the body of the patient suffered during those five days a loss of 83·35 grammes of nitrogen, representing 2·45 kilos. of flesh. Meanwhile the body weight sank from 53·279 to 52·60, thus losing in all 0·679 kilos. In a second period of six days, during which absorption of the exudation took place, the collective output of nitrogen amounted to 135·44 grammes, while the intake contained only 42·96 grammes, so that there were eliminated 92·48 grammes of nitrogen =2·72 kilos. of flesh, the body weight losing in this second period 1·502 kilo. These most instructive figures call for no further commentary, and we learn too from them that it was not until twelve days after the subsidence of the fever that the patients in question ceased to lose albumen.

In a second case watched by Huppert and Riesell a caseous pneumonia followed on typhus. The patient excreted in the course of 18 days by urine, fæces, and sputa 328·74 grammes of nitrogen, while 100·03 were contained in the food, so that the body lost in the above-mentioned period 222·71 grammes of nitrogen=6·55 kilos. of flesh, the body weight losing only 2·37 kilos.[1]

It has been long known that in the course of fevers, especially of those ending in a crisis, the increased excretion of urea not merely continues but rises still higher after the decline of the temperature. This phenomenon is, in the opinion of many observers, due to the accumulation in the body during the fever of the products of metabolism (urea or certain transitional bodies leading thereto), while others maintain that the conditions of increased albuminous metabolism continue for some time after the fall of temperature.[2]

The epicritical increase in the urea is as a rule very conspicuous in the stage of resolution of croupous pneumonia. It is very plausible

[1] H. Huppert and A. Riesell, 'Ueber den Stickstoffumsatz im Fieber,' *Arch. d. Heilkunde*, x. 1869.

[2] Cf. Jos. Bauer and Q. Künstle, 'Ueber den Einfluss antipyretischer Mittel auf d. Eiweisszersetzung bei Fiebernden,' *Deutsch. Arch. f. klin. Med.*, xxiv. part i.

to attribute a share in this phenomenon to the fibrinous exudation, the albuminates of which probably undergo metabolism in the process of absorption. It is generally believed that the liquefaction of exudations is effected by means of a fatty degeneration, in which the nitrogenous products of the splitting up of the albuminates are eliminated in the urine.

If one believe with Voit that under normal conditions it is chiefly the albuminates dissolved and circulating in the fluids of the body that undergo disintegration, while those fast bound up in the cellular tissues are metabolised only to a small extent, the question arises whether the same order is maintained in fever or not. Since, indeed, fever patients as a rule excrete a far larger quantity of nitrogen than is contained in the food, it follows that so soon as the original store of albumen circulating in the nutrient fluids is exhausted further metabolism must go on at the expense of the tissues. The same occurs in normal organisms when starving, and probably the processes differ only in the larger portion of organic albumen subjected to metabolism in fever than in simple inanition.

In starvation, according to Voit, the albumen of the tissues is not metabolised as such, nor in the condition in which it is found contained in the cells, but is first liquefied and then behaves like the circulating albumen received into the nutrient current from the alimentary canal. Since the tissues and organs are able to maintain their normal composition as regards albumen only when a due proportion of albumen is present in the surrounding fluids, the cellular tissues collectively continuously give up their albumen as the nutrient material is being withdrawn from the fluids as an effect of metabolism. The question next suggests itself whether in fever such albuminates only are metabolised as have been first liberated from their connection with the cellular tissues and circulate in the nutrient fluids, or whether, in contrast to the normal conditions, the albumen in the organs and tissues themselves is metabolised. In either case the materials for metabolism must be derived exclusively from the organs, but the reparative power and the very existence of organised tissues obviously appears to be more involved if the cells themselves are the objects of the

destruction than if these simply yield a part of their substance to the nutrient fluids.

The fact that, although in the course of febrile diseases the consumption of albumen is increased, the same products of metabolism appear as under normal conditions seems to support the view that in fever only such albuminates are metabolised as circulate in the fluids of the body, and that while the splitting up of the albuminates occurs on a far larger scale in fever it proceeds in other respects in the same way and is induced by the same conditions as in the non-febrile organism.

According to Voit the living and organised tissues are specially endowed with certain properties in virtue of which the metabolism of the materials dissolved in the fluids is induced without any actual change being effected in the form of the former, just as the yeast cells cause the splitting up of a saccharine solution into alcohol and carbonic acid. The more the dissolved albumen reacts on the cellular elements, and the more active the circulation of the fluids, the more rapidly will metabolism proceed. The power possessed by organised structures to metabolise matter is consequently not the same under all circumstances, but is raised by some conditions and depressed by others.

There is nothing to prevent our applying this hypothesis to the destruction of albumen in fever and assuming that under those conditions which the febrile processes bring with them the tissues yield up to the circulation a larger proportion of their own albumen, and that an abnormal amount of materials for metabolism is thus presented to the cells. Meanwhile the organs suffer a loss of their constituents more rapidly than in simple inanition, and the febrile organism is comparable to a normal animal a considerable part of whose tissues has been consumed by prolonged fasting, but who, in consequence of a single ample albuminous meal, has for the moment a large quantity of albumen in his circulation. But in the normal organism an equilibrium between the cellular structures and the nutritive fluids would in a short time be brought about by an assimilation of matter on the one side and its disintegration on the other, whereas in the febrile state this equilibrium

remains for a long time disturbed and cannot as a rule be restored by the inflamed cells, which in most cases lose during the course of the fever the power of absorbing matter and assimilating it to their own structure.

One might suppose that the increased consumption of albumen in fever was caused by the enhanced metabolic activity of the organised tissues, in consequence of the elevated temperature. If, that is to say, the breaking up of the albuminates circulating in the fluids were performed in a shorter time than usual a more speedy disintegration of the organs would follow, and it is easy to understand how an increased daily exchange of albumen would result; only that if we really had to do with an intensified power of metabolism in the cells we cannot see why the loss of albumen by the body could not be prevented by a proper supply of like materials in the food, given at frequent intervals. Since this explanation will not stand, the primary condition must be a loosened cohesion of the constituents of the organs, the increased consumption of albumen being secondary thereto.

Were the febrile process to exert on the organs of the body, even for a short time, no other action than inanition, we should simply find a rapid atrophy of the histological elements, not a complete destruction. As a matter of fact we do on the whole meet in fevers too with an atrophic wasting of the organs only, and not with a degenerative process in the sense that the cells perish entirely.[1] Nevertheless on the testimony of eminent authorities there not unfrequently appear, especially as a consequence of the infectious diseases, visible changes in the morphological characters of the cellular elements, such as the so-called parenchymatous degeneration, which in its higher degrees leads to a complete destruction of the affected tissue.

[1] The wasting that appears as a consequence of starvation does not affect all the organs of the body in an equal degree; some of these, indeed, as the central nervous system and the heart, undergo but an insignificant loss. This circumstance Voit explains by assuming that the organs in question, possessed of great activity, rapidly make good their loss from the nutritive fluids and maintain their composition at the expense of the voluntary muscles, &c. But I much doubt if the same occurs in febrile diseases, and in my opinion the heart and central nervous organs are not in a state to assimilate nutriment and to repair past losses.

According to Liebermeister parenchymatous degeneration is the constant consequence of fever of a particular intensity and duration. On the changes themselves he expresses himself in these words:— 'First the cells are clouded by fine granules, which sometimes early, at other times later, may be recognised to a greater or less extent as fat globules; at the same time the nuclei become indistinguishable. In higher degrees of degeneration the contours of the cells are lost, and in the highest mere granular masses or diffused detritus take the place of the cells. With the products of degeneration are sooner or later associated those of new cell formation, but if the fever be prolonged these too undergo degeneration. When the disease takes a favourable course a permanent regeneration of the structures sets in with the termination of the fever, and such a turn seems possible in certain organs, as the liver and muscles, even when the greater part of the parenchyma cells are irreparably destroyed. Regeneration is effected by the formation of new cells out of those parenchyma cells which have undergone the least degeneration and are still capable of restoration.'[1]

Cohnheim's description of parenchymatous degeneration differs in several points from that just given. While, for instance, Liebermeister maintains that the so-called 'cloudy swelling,' in which the cell contents exhibit a granular appearance, due to the presence of particles of albuminates, represents the commencement of the subsequent fatty metamorphosis, Cohnheim is inclined to consider the cloudy swelling and the fatty degeneration as two totally distinct nutritive changes. He therefore considers it as beyond question that cloudy swelling in commencing recovery would be a simple retrograde process.

Cohnheim is further of opinion that the assertions of the frequent occurrence of parenchymatous degeneration and fatty metamorphosis in fevers are not quite satisfactory. They are missed in many cases in which death is caused by intense febrile processes, and they are seen especially in infectious diseases, so that a casual connection between the degeneration and the high temperature cannot be established.[2]

A difference of opinion as to the frequency of parenchymatous degeneration can present no obstacle to connecting these changes in the organs, or at least their fatty metamorphosis, with the abnormally increased albuminous metabolism; for if in the disintegration of the albuminates in the organism fat appears regularly

[1] Liebermeister, *Pathol. u. Therapie des Fiebers*, p. 440.

[2] J. Cohnheim, *Vorlesungen über allg. Pathol.*, vols. i. and ii.

as a product of their splitting up, to be, according to the conditions present, either further metabolised or stored up in the natural fatty deposits of the body, it may be justly assumed that along with pathologically augmented albuminous metabolism an abnormal amount of such fat, the product of its splitting up, will be produced. So soon, however, as the metabolism of the fat ceases to keep pace with its production abnormal collections of fat must follow.

In fatty degeneration of the organs this abnormal accumulation of fat is effected at the expense of the albuminous constituents, and thence arises the by no means unimportant question whether the higher and highest grades of fatty metamorphosis do not testify to the possibility under certain conditions of the organic albumen undergoing metabolism as such and without being previously liquefied and merged in the circulating albumen. The fact that in fatty degeneration numerous fat drops make their appearance in the interior of the cells is easily explained, although one admit a splitting up of the circulating albumen only, for the fat may be imported into the interior of the cells, or be, so to say, legitimately produced therein. Even a complete reduction of single or numerous cells to a fatty detritus is no conclusive proof of the metabolism of living organised elements, for a cell will inevitably perish if its framework (*Bausteine*) disappear in great part by liquefaction and the fat derived from the splitting up of albumen take its place. The phenomena of fatty degeneration may, however, find their least forced explanation in the assumption that under certain circumstances the molecules of albumen are one by one dissociated from their connections and directly submitted to metabolism *in situ*, until at length the whole edifice of the cell is broken up. Such an explanation appears to me and to others important, because a fundamental distinction is thereby clearly maintained between fatty infiltration and fatty metamorphosis, although it must be admitted that no sharp demarcation exists between these two forms of degeneration.

In certain processes, marked by a characteristically rapid fatty degeneration of the organs, as, for instance, acute phosphorus poisoning, there is, together with the increased metabolism of albumen, a diminished excretion of carbonic acid and

intake of oxygen, as well as a lessened destruction of fat. On the other hand numerous enquiries have shown that in fever there is always an increased elimination of carbonic acid. In opposition to earlier isolated experiments, which seemed to tell against an increased output of carbonic acid in fever, Liebermeister first announced that in two cases of ague he had observed a marked increase in the production of carbonic acid during the paroxysm;[1] and in reports of exhaustive experiments published recently he shows that in intermittent attacks the greatest increase in the excretion of carbonic acid (30 to 43 per cent.) occurred during the pyrexial periods, and in the so-called cold stage it reached even to two and a half times the normal.[2] At the same time we must not forget that a large share in the increased production of carbonic acid in the cold stage is to be attributed to the excessive muscular action. At the acme of the fever Liebermeister found the production of carbonic acid raised by from 19 to 31 per cent., and at the commencement of the sweating stage both normal and excessive amounts of carbonic acid were observed. Results almost identical followed observations made on a patient who during convalescence from enteric fever was attacked with pleurisy, in the course of which repeated and severe rigors occurred.

Soon after the first announcement of Liebermeister on the increased production of carbonic acid in ague Leyden instituted a large number of observations on several forms of febrile diseases, which invariably showed an increase in the excretion of carbonic acid as compared with what had been noticed under normal circumstances. In two patients with recurrent fever the increase in the carbonic acid was 30 to 44 per cent., in one case of typhus 38 per cent., and in one of pneumonia 70 per cent.[3] The average proportion between the production of

[1] C. Liebermeister, 'Untersuchungen über die quantitätiven Veränderungen der Kohlensäureproduction beim Menschen,' *Deutsch. Arch. f. klin. Med.*, vol. vii. p. 75.

[2] *Deutsch. Arch. f. klin. Med.*, vol. viii. p. 153, and *Pathol. u. Therapie des Fiebers.*

[3] H. Senator, *Untersuchungen über den fieberhaften Process u.s.w.* The excessive excretion of carbonic acid in pneumonia is due, according to Senator (op. cit. p. 110), to the accelerated respiration. Silujanoff has also

carbonic acid in fever and in health was as $1\frac{1}{2} : 1$. Leyden could not obtain any constant results from experiments on animals; in them a higher temperature seemed to be attended sometimes with an increase and at other times with a diminution in the amount of carbonic acid expired.[1]

Senator also in his experiments on febrile animals found no constant increase in the excretion of carbonic acid; at any rate such was not observed in the initial stage of the fever. From a critical examination of the actual materials available on the material gain and loss in fever and the results of his own experiments he came to the conclusion that the increased elimination of carbonic acid in fever is in no way the consequence of increased combustion of fat, and that fatty and albuminous metabolism bear no proportion to one another. One must indeed admit that in fever not more but less fat is burnt than under similar conditions and normal temperature, and that the body in fever, though poorer in albumen, is relatively richer in fat.[2]

In support of the last position Senator appeals to certain of his experiments in which the largest output of carbonic acid was observed. The animals the subjects of these experiments gave off at the height of the fever 4·206 grammes CO_2 in an hour, which makes for 24 hours 100·9. In this period 14·48 grammes of urea were passed, for which 42·7 grammes of albumen were metabolised. But since by the metabolism of 42·7 grammes of albumen 72·2 grammes of carbonic acid are produced, the animal could not in the 24 hours of fever have metabolised more than 10·2 grammes of fat, yielding 28·7 grammes CO_2. In a like period, but without fever, the animal had excreted 7·895 grammes of urea and 67·2 grammes CO_2, representing the metabolism of 23·3 grammes of albumen and 9·9 grammes of fat. While, then, the consumption of albumen had been raised more than 80 per cent. an increased combustion of fat could scarcely be proved.

Quite recently Leyden and Fränkel have published a number of experiments on the excretion of carbonic acid in fever, which are of great value as having been carried out with

shown that it is much greater in fevers with than without excessive respiratory activity.

[1] E. Leyden, 'Ueber die Respiration im Fieber,' *Deutsch. Arch. f. klin. Med.*, vol. viii. p. 536.

[2] H. Senator, *Untersuchungen über den fieberhaften Process u.s.w.*

the aid of the most exact appliances.[1] From the results of these experiments it follows indisputably that the fever induced by the injection of pus is in animals constantly followed by an increased elimination of carbonic acid.

In all these experiments the animals were deprived of food, and the amount of carbonic acid given off in a condition of fasting accurately ascertained. Since in healthy animals the elimination of carbonic acid steadily decreases with prolonged inanition, it was possible to determine whether such a falling off in the production of carbonic acid continued during fasting after fever had been set up by the purulent injection, or whether the operation were followed by an increase instead of a decrease. As a matter of fact the elimination of the gas was always greater in the later days of fasting with fever than in the earlier days without fever, the absolute rise varying between 4 and 56 per cent. But if one compare the elimination of carbonic acid by a fevered dog with that by a healthy one, the two having fasted for the same number of days, we find an excess in intense fever of 70 to 80 per cent., in moderate fever of 40 to 50 per cent., and in slight and temporary elevation of temperature of 10 to 20 per cent.

Leyden and Fränkel from their experiments came to the conclusion that the consumption of material is in fever raised *in toto*, and that at the height of the febrile process not only more albumen but also more fat is metabolised than under normal conditions. That in fever there is not merely an increased elimination but also an increased production of carbonic acid is best shown by the experiments of Colasanti, who found in a feverish guinea-pig an increase of 18 per cent. in the oxygen absorbed and of 24 per cent. in the carbonic acid given off.[2] With the view so strongly put forward by Senator that the

[1] E. Leyden and A. Fränkel, 'Ueber den respiratorischen Gasaustausch im Fieber,' *Virch. Arch.*, vol. lxxvi. p. 136; see there also a criticism of Wertheim's researches, 'Ueber den Lungengasaustausch in Krankheiten,' *Deutsch. Arch. f. klin. Med.*, vol. xv., and 'Untersuch. über den Stoffwechsel in fieberhaften Krankh.,' *Wien. med. Wochenschr.*, 1878, Nos. 32–35.

[2] G. Colasanti, 'Ein Beitrag zur Fieberlehre,' *Pflüger's Arch.*, vol. xiv. p. 125, 1877.

The observations of Colasanti on the consumption of oxygen in a febrile animal long remained isolated, and it is only very recently that D. Finkler has, by a preliminary observation, given a promise of conducting a searching

body is after the abnormal metabolism of fever poorer in albumen, but relatively richer in fat, both observers agree so far as to allow that the albuminous metabolism in fever stands in no relation with the destruction of fat. The question whether in fever not only the albumen and the non-nitrogenous products of its splitting up, but also the fat distributed throughout the body are subjected to metabolism to a greater degree than under normal conditions can only be answered when the total intake and output of the fevered organism is ascertained; for only from a review of the whole material economy in fever can one decide whether the total carbon given off from the body is covered by the albuminous metabolism or whether the non-nitrogenous constituents of the body are also broken up.

An increased interchange of gases also occurs when the temperature of the body is raised by preventing the escape of heat, as Pflüger has demonstrated.[1] But since a considerable elevation of temperature has, according to the experiments of Litten, been found to lead after some time to a diminished interchange of gases and a fatty metamorphosis of the organs,[2] one must conclude that an artificial elevation of the body temperature induces first an increase of the metabolism of matter in general, but that when the heat has been maintained for a long time the increased metabolism of the albumen alone continues, while that of the fat fails to keep pace with it, or may

enquiry into the exchange of gases in febrile states. According to this preliminary communication the febrile elevation of the temperature led to—

At a Surrounding Temperature of	Increased Absorption of Oxygen	Increased Exhalation of Carbonic Acid
°C.	Per Cent.	Per Cent.
of 25·64	+ 20·9	+ 22·8
„ 6·10	+ 10·8	+ 4·4
(a) Fever temperature of 40°–41°		
of 26·20	+ 19·8	+ 18·1
„ 6·99	+ 19·4	+ 12·4
(b) Fever temperature of 39°–40°		
of 25·16	+ 23·2	+ 26·8
„ 5·55	+ 4·4	+ 6·5

[1] E. Pflüger, 'Ueber Wärme und Oxydation der lebendigen Materie,' *Pflüger's Arch.*, vol. xviii. 1878.

[2] Litten, *Virch. Arch.*, vol. lxx.; cf. also Erler, *Ueber das Verhältniss der Kohlensäureabgabe zum Wechsel der Körperwärme*, Königsberg, 1875.

even absolutely decline. That similar conditions obtain in fever cannot, it is true, be proved, although we must not assume that the increased excretion of carbonic acid is exclusively a consequence of the elevation of temperature.

In the preceding pages the exchange of material in fever has been discussed in the light of recorded experiment so far as appeared necessary for forming a correct estimate of the magnitude of the loss which the body experiences in the course of febrile diseases. One may confidently assert that the accelerated exchange of matter, especially the increased metabolism of the albuminates of the organs, is to be considered one of the most important consequences of febrile diseases. We have not in fevers to deal with a rapid wasting of the organs only, such as occurs, though more slowly, in simple inanition, in which the cells, although in an atrophic condition, hold together fairly: it is here the cellular elements themselves that are attacked and broken down. Thus it follows that the reaction of the metabolism of fever on the functional activity of organs must be totally different from what occurs in inanition, and that the activity of the cells may cease long before any striking emaciation of the body has been brought about. This position is easily accepted if we believe that the destruction of fat does not keep pace with the loss of albumen in the subject of fever. The fact that in starvation death does not take place until a large proportion of the collective mass of the body is wasted, and the supply of fat has almost entirely disappeared, cannot be applied without great qualification to the febrile state, and it would be an error to measure the consequences of the abnormal waste and destruction of substance in fever patients by the degree of visible emaciation alone.[1]

In respect of the inorganic products of excretion, Salkowsky has established the remarkable fact that during fever the elimination of potash salts by the urine is increased,[2] which is doubtless connected with the increased destruction of tissue.

[1] Very fat subjects usually bear starvation for long, but succumb to febrile diseases in a surprisingly short time, a difference which can be in part explained by the different course of metabolism in starvation and in fever

[2] E. Salkowsky, 'Untersuchung über d. Ausscheidung d. Alkalisalze,' *Virch. Arch.*, vol. liii.

It has also been long known that the excretion of the urinary chlorides is diminished during acute febrile processes. According to Röhmann, who has lately sought to ascertain the causes of the diminished excretions of chlorides, there is a partial retention of these salts in the body of a fever patient, since a part of the salts taken with the food does not reappear. Röhmann sees the ground of this retention of sodium chloride in the bodies of febrile subjects in the large quantity of organic albumen which has passed into the general fluids, liberating the potash salts from their combination with the albuminates and replacing them by salts of sodium.[1]

The Effects of Food on the Febrile Subject.

The notion that the administration of food intensified febrile conditions, and was therefore detrimental to the patient, was at no time perhaps a purely arbitrary one, but without doubt was founded on certain experience—the observation, for instance, that convalescents not seldom exhibit a renewal of fever when they begin after a long time again to take solid food in considerable quantity. From the earliest times animal foods were held to be specially injurious to such patients—that is to say, flesh meats, to which highly stimulating properties were ascribed, and which were thus opposed to most vegetable foods. When men began to distinguish more accurately between the alimentary principles contained in the various foods, and to attribute to each its special action in the economy, they believed that the doctrine of the ancient physicians still held good, but in the form that 'the administration of albuminates is specially to be deprecated in febrile diseases.'

The thesis was by some supposed to have received a direct verification when Huppert and Riesell in their researches into nitrogenous metabolism found that after the free administration of albuminates to febrile subjects more nitrogenous products of metabolism were excreted by the urine than with a diet poor in albumen.[2] From these researches most authorities have concluded that in fevers not only can no nitrogenous equilibrium be

[1] F. Röhmann, 'Ueber die Ausscheidung der Chloride im Fieber,' *Zeitschr. f. klin. Med.*, vol. i. 1880.

[2] H. Huppert and A. Riesell, 'Ueber den Stickstoffumsatz im Fieber,' *Arch. d. Heilkunde*, x. 1869.

obtained by any supply of albuminous food, but that the withdrawal of albuminates from the body and the disintegration of its structure is still more accelerated. That this is, however, not always the case was first, so far as I know, maintained by Uffelmann in consequence of a precisely opposite experience. But Immermann was the first to demonstrate that the researches of Huppert and Riesell do not justify the conclusion that the administration of albuminates intensifies the febrile consumption and is comparable to pouring oil on a fire.[1]

Two series of observations are recorded by Huppert and Riesell, in which the nitrogen contained in the intake and output was exactly estimated. The first was the case of a man aged twenty-five years, who was attacked with a croupous pneumonia on December 18 and came under observation on the 21st. From that day to the 25th the fever was high, but from the 26th to the 30th moderate, complete absorption of the exudation taking place meanwhile. During the two periods the following estimates were made :—

Date	Nitrogen in Food	Nitrogen of Excreta				Nitrogen Withdrawn from Body	Body Weight. Kilos.
		Fæces	Sputa	Urine	Total		
Dec. 21	0·18	—	0·21	18·43	18·64	18·46	53·279
,, 22	0·91	1·19	0·30	15·91	17·40	16·49	53·447
,, 23	0·75	1·34	0·45	16·33	18·12	17·37	53·659
,, 24	0·90	0·16	0·51	15·40	16·07	15·17	53·011
,, 25	0·21	0·30	0·36	15·41	16·07	15·86	52·60
,, 26	0·02	2·09	0·14	22·81	25·04	25·02	49·950
,, 27	4·38	0·68	0·14	23·14	23·96	19·58	50·002
,, 28	4·45	2·99	0·10	22·36	25·45	21·00	50·450
,, 29	9·0	2·14	0·15	22·09	22·38	13·38	50·958
,, 30	8·40	2·12	0·11	16·73	18·96	10·56	50·885

The observations were continued for some time after the patient was entirely free from fever, but the numbers then obtained are of course of no service towards the solution of the problem what effect the administration of albuminates has on albuminous metabolism in fever. But the extract from the observations that I have given certainly does not prove that the loss of nitrogen from the body rises with the increased supply of albuminous food, for in the period of high fever the patient received a diet proportionately poor in nitrogen, and in that of resolution with a less degree of fever the critical increase in the excretion of urea became apparent, while with the more liberal supply

[1] H. Immermann, *Handb. d. allg. Ernährungsstorungen*; V. Ziemssen's *Handb. d. spec. Pathol. und Therapie*, vol. xiii. 1879.

of albumen from the 27th, and still more from the 29th, no further increase was observed.

The second case was one of convalescing typhoid complicated by cheesy pneumonia. The patient manifested febrile symptoms with slight oscillations up to the time of his death, and the intake and output of nitrogen were as follows :—

Date	Nitrogen in Food	Nitrogen in Excreta				Nitrogen Withdrawn from Body	Body Weight. Kilos.
		Fæces	Sputa	Urine	Total		
Jan. 4	3·12	0·96	0·21	12·41	13·58	10·46	58·330
,, 5	2·44	0·61	0·15	10·16	10·92	8·48	57·891
,, 6	3·36	1·36	0·15	11·97	13·48	10·12	58·217
,, 7	8·18	1·66	0·81	16·65	19·12	10·94	57·730
,, 8	9·13	1·52	0·80	17·75	20·07	10·94	56·870
,, 9	11·96	1·53	0·71	18·94	21·18	9·22	56·055
,, 10	9·02	1·05	0·52	17·12	18·69	9·67	55·030
,, 11	1·20	0·75	0·52	15·02	16·25	15·05	54·877
,, 12	1·20	1·51	0·39	13·42	15·32	14·12	54·735
,, 13	1·21	0·70	0·39	12·12	13·21	12·00	55·935
,, 14	5·94	0·45	0·39	15·78	16·62	10·68	55·270
,, 15	5·30	0·93	—	16·14	17·07	11·77	—
,, 16	5·46	1·31	—	17·61	18·92	13·46	—
,, 17	6·57	0·78	—	19·93	20·71	14·14	—
,, 18	6·57	1·38	—	16·99	17·37	10·80	—
,, 19	6·51	2·48	—	23·34	25·82	19·31	—
,, 20	6·51	1·99	—	23·22	24·51	18·00	—
,, 21	6·35	0·75	—	19·45	20·20	13·85	—

From these researches it clearly appears that the ingestion of albumen can in no case prevent a loss of albumen from the body of a febrile subject, although it must be remarked that on most of the days during which the patients were under observation the amount of nitrogen in the food was certainly not sufficient to meet the requirements even of an individual free from fever. It is further seen that an increased supply of albuminous food induces as a rule an augmented excretion of nitrogen, but the same relation is observed in the healthy subject; the question therefore should be put thus: Is the loss of nitrogen greater with a highly nitrogenous diet than with one poorer in nitrogen? An affirmative answer, however, cannot be drawn from the results of Huppert and Riesell's experiments; more often, as Immermann had already urged, the lowest figure for the nitrogen withdrawn from the body, corresponds with the highest for the nitrogen taken in with the food, and *vice versâ* the body suffers the greatest loss of nitrogen when the albumen in the food is least. At the same time it must not be forgotten that the experiments were made on sick persons, in whom probably the conditions for a balance

of gain and loss of albumen were wanting, and that thus the effects of the ingestion of albumen on the nitrogenous metabolism did not appear with the regularity and precision that they would under other and normal conditions.

The assumption that the administration of albumen to fever patients not only effects no saving of albumen, but accelerates the disintegration of the tissues, is clearly negatived by a course of experiments which I made jointly with Künstle. We gave to a typhoid patient a diet almost entirely free from nitrogen alternately with one containing a large amount of albumen, and obtained the following results:—

Date	Nitrogen in Food	Nitrogen in the Excreta			Nitrogen Withdrawn from Body
		Urine	Fæces	Total	
26	0·8	13·26	0·76	14·02	13·90
27	0·8	14·02	0·45	14·47	14·35
28	0·8	15·79	0·70	16·49	16·37
29	39·5	—	0·27	—	—
30	39·5	17·12	0·12	17·24	11·08
1	39·5	17·15	0·20	17·35	11·19
2	39·5	17·16	—	17·16	11·00
3	0·8	15·27	—	15·27	15·15
4	0·8	14·02	0·41	14·43	14·31
5	39·5	17·63	—	17·63	11·47
6	39·5	17·24	—	17·24	11·08
7	51·7	14·98	—	14·98	6·91
8	51·7	14·32	—	14·32	6·25
9	51·7	14·85	—	14·85	6·78
10	51·7	14·97	—	14·97	6·19 [1]

From the table just given it follows indisputably that by the supply of albuminous food to a fever patient a saving of albumen in the body may be effected, for though the excretion of nitrogen is increased the loss of the same element from the system is reduced. At the same time it must be observed that the diet did not consist of pure albuminates, but of mixed food rich in nitrogen, though containing also fat and carbohydrates as well as albumen.

[1] The foods supplied to this patient consisted chiefly of soups, eggs, and milk. The nitrogen in 100 grammes of dry albumen was estimated after Henneberg at 15·61 grammes. From the 7th (the twelfth day of observation) the fever began to decline, which doubtless affected the excretion of nitrogen (J. Bauer and G. Künstle, 'Ueber den Einfluss antipyretischer Mittel auf den Eiweissumsatz bei Fiebernden,' *Deutsch. Arch. f. klin. Med.*, vol. xxiv. part i.).

If the ingestion of albumen in fever effected no saving of albumen it would follow that the albumen which passes from the intestine into the current of nutrient fluids would be subjected to metabolism, but that, nevertheless, the disintegration of the tissues would proceed just as in starvation. Since, however, the loss of albumen in febrile subjects is lessened by the administration of albumen, one must conclude either that the disintegration of the tissues is checked by the circulation around them of a highly albuminous fluid, or that the liberation of the organised albumen from its combination proceeds as in inanition, and that in this case only the circulating albumen is saved.

Whether in highly febrile states the loss of albumen from the body could be entirely prevented is, for obvious reasons, very difficult to determine, but it appears to me unlikely; for while under normal conditions a sort of equilibrium is constantly maintained between the nutrient fluids and the tissues, any excess of nutrient material being speedily removed, partly by increased metabolism and partly by an accession of substance, this equilibrium appears to be more or less disturbed in fever. The circulating current of albumen is abnormally great in proportion to the mass of cells; but the heated cells cannot assimilate this excess, since they have lost, at least in part, the capacity for taking up and turning material to their own use. A nitrogenous equilibrium cannot be attained in patients with high fever, even if they were in a condition to absorb large quantities of albumen. The possibility of compensating the loss of albumen by nourishment will be greater if the fever shows more or less marked remissions or intermissions, because, as it seems to me, the cellular elements recover during the intervals of remission the power of adding to their substance and of metabolising the excess of nutrient material.

Further investigations into the manner in which the exchange of matter in febrile subjects is conducted under the administration of the foodstuffs, singly or combined in various proportions, are as yet wanting. There are, nevertheless, different speculations as to the material effects of single food stuffs in fever; but they are based for the most part on isolated

observations or on experiments conducted under normal conditions, and therefore not applicable without qualification to the febrile state. Thus a great value is ascribed to the carbohydrates in the nutrition of fever patients, from the physiological fact that by these easily metabolised matters the waste of albumen is kept within narrow limits and the loss of fat can be entirely prevented. But, even supposing that the carbohydrates produce identical effects in the febrile and in the healthy subject, we cannot forget that they are of great value in the animal economy only when combined with a certain proportion of albuminates, while alone they have scarcely any power of postponing death from starvation.

From a consideration of the fact that albuminous metabolism is increased by the administration of albuminous food Senator strongly recommends gelatin in the nutrition of fever patients, since this foodstuff does not increase, but on the contrary lessens, the consumption of albumen. There would, however, be little actual advantage in the metabolism of gelatin in place of albumen; though it would clearly be such if the material for metabolism were derived from the food and thus protected the organised albumen from waste. But then gelatin is not physiologically equivalent with albumen, and must, for the same purpose, be given in much larger quantities than albumen, which presents decided advantages. Nevertheless, everyone will freely admit the great value of gelatin in the nutrition of fever patients, just because it is as a rule well borne and easily absorbed into the general fluids.

If one would form a judgment as to the value of food in fever in its entire extent one must not be satisfied with a mere knowledge of its material effects, but must much rather take into consideration its influence on the functional capabilities of the several organs; for it is *à priori* at least improbable that in a fever patient the functions of the heart, of the central organs, of the nervous system, &c., can be performed with the same energy and regularity when the organism has been for a long time in a state approaching inanition or has been in the enjoyment of a certain amount of nourishment. In proof of this one has but to appeal to experience, as of the delirium of

inanition, and to a comparison with the normal organism, but more exact data unfortunately do not exist.

While little regard has hitherto been paid to the bearings of metabolism and the absorption of nutriment on the mechanical functions of the febrile subject, the question whether the temperature of the patient is still further varied by the ingestion of food has, on the other hand, been often and warmly discussed. The *à priori* possibility of the elevation of the temperature in fever as a consequence of a liberal administration of food cannot be denied, since there is no doubt that a direct connection exists between the acceleration of metabolism and the increased production of heat thereby on the one hand and the elevation of the body temperature in fever on the other. One might further conclude that the temperature would rise so much the higher as the more matter was subjected to metabolism, whence it would also follow that the administration of nourishment would cause an increase of temperature, because the activity of the metabolic processes would be increased thereby. But the elevation of temperature in fever cannot be due solely to increased metabolism and heat production, for in the normal state the production of heat consequent on abundant nutriment, and certainly on sustained muscular exertion, may be far greater than in fever, without the temperature of the body being raised more than a fraction of a degree. It admits of no doubt that in fever the regulatory arrangements which enable the normal organism to maintain a constant temperature, although the internal production of heat oscillate between wide limits, in some way or other partially lose their efficiency. On this point, again, there is divergence of opinion among different authorities, and lastly it is almost universally agreed that there is in fever not a complete arrest of the regulation of heat, but merely an insufficient or defective performance of the regulatory function.[1] We are, however, not yet in a position to define the irregularities in the me-

[1] Murri, dissenting from the great majority of authorities, maintains that in fever the regulation of heat is performed exactly as in health, but that production rises continually and without any pause, whereas under normal conditions an increased evolution of heat is never more than temporary, the regulatory apparatus having time in the intervals to remove the excess. Quoted by Cohnheim, *Vorlesungen über allg. Pathol.*, vol. ii. p. 529.

chanism of heat control, and to determine with certainty on the ground of our actual knowledge whether the administration of food to a fever patient does or does not induce an elevation of temperature.

According to the definition of Liebermeister 'fever is an aggregate of symptoms depending on changes in the regulatory function, whereby the production of heat is increased, and the ratio of the loss thereto is such that an abnormally high temperature of the body ensues.' The nature of the disturbance of the heat economy in fever is, in his opinion, best imagined by supposing the regulation of the temperature to be fixed at a higher standard than the normal; the regulation of heat is conducted during fever in a manner precisely analogous with what takes place in health, only with this difference: that a higher degree of temperature is maintained by the body and that the sluices, so to say, for the overflow of the excess of heat do not, as in health, open at 37° C. (98°–99° F.), but only at higher temperatures.

Against this explanation by Liebermeister of the febrile anomalies in the heat control Senator has urged with force that the conditions under which the body heat of a fever subject is maintained differ from those of the normal state in showing an abnormal variability or instability of temperature, instead of the permanence observed in health under the most diverse circumstances. This fact speaks most decidedly for an insufficiency of the regulatory apparatus and not for its being simply fixed at a higher point, which would otherwise be adhered to with the same constancy as the normal. The anomalies in the regulation of the temperature in fever are, according to Senator, mainly referable to the abnormal behaviour of the cutaneous vessels; for whereas, in order to get rid of the excess of heat, they ought to be constantly relaxed, they are in fact continually alternating between the extremes of contraction and dilatation, and this in consequence of the abnormal irritability of the vasomotor nerves that the fever itself induces. According to this view, which has recently received a general approval from Cohnheim, the elevated temperature of fever is explicable by a disturbed activity of the cutaneous vessels, which, though they indeed set free on the whole more heat than under normal conditions, do not always meet the increased heat production by a prompt dilatation, but often assume, whether from internal or external causes, a temporary state of contraction.

At present an answer to the question whether the ingestion of food in fever induces an elevation of temperature can only

be attempted on the ground of experience. At the same time it must be observed that it is very difficult to arrive at a certain decision whether in any particular case the administration of food have or have not caused a rise of temperature; we may, however, notice whether the greater variations of temperature are proportional to the amount of food taken. That such is actually the case has not been shown by anyone; on the contrary, many observers have testified that fever patients may take considerable quantities of nourishment without any remarkable rise of temperature. Yet the accuracy of the contrary observations described above need not be rashly impugned, for if such cases are more closely examined it will, as a rule, be found that the caution as regards either the choice of food or the quantity administered at a time, which appears imperative in view of the weakened capacity of digestion, has been neglected. Such rise of temperature usually passes off in a short time after digestion is completed, clearly proving that it is connected with the digestive process and not with the effects of nutriment after its reception into the general current and the increased oxidation consequent thereon; for otherwise it would first become apparent at the time when the temperature actually subsides. But if the ingestion of unsuitable food have seriously damaged the organs of digestion it is intelligible that the rise of temperature should in such cases be persistent.

From the previous discussion it admits of no doubt that the waste of matter, especially the metabolism of albumen, experiences a decided acceleration in fever, and that consequently the cellular elements lose in a short time a part of their constituents and may in certain circumstances perish altogether. It is more than probable that the great consumption of organic albumen, especially if it should lead to actual degeneration of the tissues, inflicts a far greater injury on the functional capacity of the organs most essential to life than is the case in simple starvation, in which the heart and central nervous system maintain their integrity for a long time at the expense of the other organs. Since, however, it is proved that the waste of the body substance in fever may be considerably checked by the reception of nourishment, it follows that the administration of a certain quantity of food is a powerful means of keeping within

limits the injurious consequences of increased metabolism. This problem would be an illusion if the taking of food invariably induced an increase of fever, but this seems to be the case only when certain conditions are not fulfilled.

Since in fever the metabolism of albumen is increased far more than is the combustion of fat, and from its bearing on parenchymatous degeneration is of the greatest consequence, it is evident that the gravest possible injury to the organism of the fever patient may be brought about by a diet rich in albuminates. What is the most suitable combination of nitrogenous and non-nitrogenous foods for fever patients, and whether this should be changed on the advent of symptoms of weakness, in the successive stages of the fever, &c., must be ascertained by future investigation. The albuminates of the food may to a certain extent be replaced by gelatin, which, from the ease with which it is absorbed, is well adapted for such cases. A diet composed exclusively of carbohydrates could, we may presume, fulfil only to a very limited extent the purposes we have in view, for though the influence of these substances on metabolism in fever is not yet definitively ascertained by experiment, it is at least highly probable that they are immediately metabolised without saving the body even approximately so much albumen as is effected by the administration of albumen in the food.

The principal ground on which a special advantage was ascribed to such foods as contain a preponderance of carbohydrates in the Hippokratic regimen of acute diseases must not, I think, be sought in their material effect, and rests solely on the experience that some of these preparations—as, for example, barley water, &c.—are well tolerated by fever patients.

On the Performance of Digestion in Fever.

From a knowledge of the metabolic processes as performed during fever on the one hand, and of the effects on it of the several foodstuffs, or combinations of them, on the other, we have without doubt the most important data for the nutrition of fever patients. These, however, must undergo considerable qualification in view of the fact, already insisted on, that the

activity of the digestive organs is more or less reduced. The quantity of nutriment which, in view of the waste that goes on in the organism of a fever patient, would constitute an ideal diet can in practice be rarely and only exceptionally administered without running a risk of seriously injuring him. The amount of nourishment that the fever patient receives must never exceed his powers of digestion, and such foods only should be used as are either capable of being absorbed immediately and without further action of the digestive juices or demand the very smallest amount of digestion and cannot either chemically or mechanically irritate the gastro-intestinal mucous membrane.

The alterations which the digestive processes usually undergo in consequence of febrile diseases are very various in degree; not only is there a great difference in this respect between acute and chronic febrile conditions, but the nature of the morbid process, the intensity of the fever, the age and constitution of the patient, as well as his previous mode of life, all have their influence. Obviously the gravest disturbance of digestion occurs when structural changes seriously involving the organs employed are either in direct connection with the febrile affection or are present as complications. This last is often the case when the patient has an attack of indigestion shortly before or in the course of the fever.

In the higher grades of febrile derangements of digestion there is an entire absence of appetite, or it may be an actual aversion and disgust for food; at the same time the digestive juices are secreted in unnaturally small quantities and are, some at least, of insufficient activity; the peristaltic movements too are not performed with regularity. In most the digestive energy of the stomach seems reduced, since the digestion of albuminates is the most imperfect. When food, and especially the less soluble albuminates, is ingested in the solid form, the contents of the stomach are retained for an unusually long time, undergoing abnormal putrefactive and other changes, the products of which set up intense irritation of the gastric mucous membrane. The firmer the consistence of the foods ingested the less can their digestion be expected, and the more mechanical irritation will they inflict on the

mucous surfaces. The patient, after having taken food to the digestion of which he is not equal, feels greatly oppressed ; pain in the region of the stomach, disgust, and nausea follow, and later abdominal pains and distension, and not unfrequently these symptoms of intense gastro-intestinal catarrh go hand in hand with an increase of the fever.

These prejudicial effects of the ingestion of food are the less likely to be produced the greater the care taken in the selection of the nourishment that the efforts of the digestive organs shall be as little as possible called into play. On the strength of accumulated experience one may confidently assert that in a great number of fever cases a certain proportion of the several food stuffs may be taken without any injurious consequences, provided the matters introduced are either ready for immediate absorption or at least require no energetic action of the gastric juices. Obviously even these articles of food must be given only in such quantities as cannot possibly overload the stomach, and that absorption may keep pace with ingestion, for an excess in quantity will lead to the like consequences as an error in the choice of the food.

In many febrile diseases the digestion may be enfeebled to such a degree that even the absorption of substances in solution may be performed imperfectly or not at all. In these cases the smallest quantities of fluid nourishment are frequently rejected by the stomach, or if not they irritate its mucous membrane, since, not being absorbed, they undergo a gradual putrefaction. Under such circumstances one must naturally abstain more or less completely from all attempts at feeding so long as this grave state of things continues, since no good purpose can be served and the evils may be aggravated by food. This condition is most often seen at the commencement of acute febrile diseases, especially inflammatory affections of the abdominal organs.

In contrast with these cases, in which the digestive energies have been seriously implicated, we meet with others in which the appetite has not in the least fallen off, and such patients are accordingly able not only to enjoy considerable quantities even of solid food, but manifestly to digest it. This is most frequently the case in chronic febrile states, though not always

in those, and it occasionally happens that in acute fevers, as the aseptic wound fevers recorded by Genzmer and Volkmann among others, the appetite is not materially affected and a liberal diet can be partaken of without injury.

The favourable or unfavourable results of the administration of food in fever depend mainly on the immediate reception of the nutriment into the fluids of the body or not, so that as a rule the food must be adapted both as to quality and quantity to the patient's power of digestion for the time being. Now it may be laid down as a general rule that the state of the appetite affords important indications as to whether the disturbance of the digestion be great or of little moment, but we do not possess any accurate measure by which we can estimate the functional activity of the digestive organs. It is therefore advisable always to begin with small quantities of those foods which are known to be most easily digested and gradually to increase the doses.

The difficulties with which the feeding of fever patients is beset could to a great extent be avoided if we could give all nourishment in a state of solution, so that it should not require to be digested, but merely absorbed. The different articles of food and their usual preparations contain indeed one or other of the food stuffs in solution, but a dish that shall contain all alike dissolved has not yet been invented. The albuminates especially being almost always taken in forms in which they are not fit for immediate passage into the general fluids of the body, many attempts have been made of late to provide for the use of invalids solutions of albuminates which may be absorbed without any previous action of the gastric juice. The *infusum carnis frigide paratum*, the fresh expressed juice of meat, the Leube-Rosenthal solution of meat, as well as the various peptone preparations obtained by means of artificial digestion, fulfil this condition. The carbohydrates are more easily available for absorption in the fluid form, since one has only to substitute saccharine solutions for the starches, and recently Buss has recommended the commercial grape sugar as particularly appropriate. On the other hand we have no practicable means for rendering the fats more digestible, so that most authorities agree in advising that the fat supply

in fever should be restricted as much as possible, and that in those cases in which the administration of fat appears urgently required, viz. in chronic febrile diseases, those fats should be chosen—as butter, cod-liver oil, &c.—which experience shows to be most easily digested.

The solutions of the foodstuffs, and more especially of the albuminates, are without doubt of great value in the nutrition of fever patients; but their use must always be limited, since neither in health nor in disease are men capable of enjoying continuously for any length of time a large quantity of substances which, even if not actually distasteful, are at least insipid and monotonous. The demand for relishes and for a certain variety of gustatory impressions soon makes itself so urgently felt that the attempt to support a fever patient for long on a diet composed exclusively or mainly of the above-mentioned solutions of the foodstuffs will inevitably lead to an insuperable repulsion and finally to vomiting. The administration of such pure foodstuffs must always be carried out with moderation and caution; they can as a rule be looked on as adequate only when supplemented by certain relishes and stimulants. Occasionally it is not only desirable but imperative that the greatest part of the nourishment should be administered artificially, i.e. per rectum, and for this purpose these solutions of the foodstuffs are especially appropriate.

In many cases of fever the power of digestion is not so enfeebled that small quantities of certain foods are not available for absorption. Experience teaches that in many cases all the injurious consequences of food can be avoided if only one give to the patients in question a fluid diet in which some of the aliments are in a state of solution and others of very fine suspension. Such are the soups, with various additions, eggs too, lightly boiled or beaten up, and milk, which indeed coagulates in the stomach, but may, by proper precautions, be made to form a soft and harmless curd. Gelatin is a useful addition to soups; and one can, as a rule, give to patients who do not suffer from an extreme degree of febrile dyspepsia such light acidulated jellies as those prepared according to the directions of Wiel, without any apprehension of ill effects.

How far the various foods are really utilised by fever

patients and received into the nutrient currents we have at present little and but unsatisfactory information. H. v. Hoesslin has instituted a course of such experiments in typhoid fever, the results of which will shortly be published; but he has kindly communicated to me the mean numbers representing the value obtained from several articles of food.

Nature of Principal Food	In the Food				In the Fæces			No. and Character of Daily Evacuations
	Organic Matter	Nitrogen	Fat	Carbo-hydrates	Organic Matter	Nitrogen	Fat	
Egg and milk . .	221·0	9·9	64·2	94·0	13·9	1·13	5·37	2–5 diarrhœal
Raw ham . . .	181·0	20·2	17·1	40·1	17·5	2·14	3·58	3–7 ,,
Milk	254·0	12·36	73·5	102·0	13·7	0·99	6·43	1–2 gruelly
Meat juice. . .	114·0	12·83	1·50	28·7	6·23	0·46	1·73	1 ,,
,, ,, . . .	107·3	15·0	1·20	12·0	12·5	1·20	1·81	4 diarrhœal
Wheaten gruel . .	626·0	22·5	107·7	378·0	30·4	1·62	10·0	1 gruelly
Semolina ,, . .	347·0	12·3	59·5	211·0	31·45	2·24	4·12	4 diarrhœal
Yolks of eggs . .	239·0	11·25	135·0	34·0	14·3	0·76	9·06	1 semisolid
,, ,, . .	210·0	10·1	121·0	26·0	13·3	1·09	6·9	2 diarrhœal
Cooked ham . .	110·0	15·05	7·4	8·7	8·97	0·93	1·87	2 ,,

These experiments show that in a number of patients certain foods of acknowledged digestibility were very fairly utilised, and that in particular the greatest part of the albuminates was absorbed. One cannot, indeed, expect such good results as these in patients labouring under the severer forms of febrile dyspepsia; they are, however, enough to show that the quantity and the quality of the food must be adapted to the patient's digestive powers for the time being.

From the earliest ages it has been recognised by physicians that different rules must be followed in the dieting of acute and of chronic febrile processes. The justice of such a distinction is evident when one reflects on the impossibility of persevering for months together in a rigidly restricted diet without bringing on death by inanition. On the other hand the shorter the duration of a fever the less has one to fear a dangerous degree of wasting, unless one have from the first to deal with very enfeebled individuals. Again, it is to be borne in mind that several of the conditions which make it desirable to restrict the diet in acute febrile processes, especially the derangement of the digestive function, are absent, or present in a slight degree only, in the chronic cases. We may also take it

for granted that the intermissions, or even the remissions, that occur so frequently in chronic febrile diseases are of advantage to the digestive powers (see p. 193). Certain observations moreover seem to indicate that in prolonged febrile states the organism becomes, to a certain extent, accustomed to the abnormal temperature, and that the consequences of the fever are less pronounced.[1]

In the vast majority of cases of acute febrile diseases the conditions are such that it is quite useless to think of maintaining the weight and composition of the body, and food is given with the aim of partially at least saving its constituents from destruction and that the richer current of nutrient fluids may exercise a beneficial influence on the functional activity of the vital organs. In chronic febrile states, on the other hand, the nutrition should, at least when possible, obviate any loss of weight by the body even if any actual gain be impossible. This end would most assuredly be gained only in the rarest cases if waste of tissue, and especially metabolism of albumen, were increased at the same rate as in acute fevers. We do, indeed, possess certain data from which we may conclude that the metabolic processes in chronic febrile diseases are in general on a small scale. Thus it is that in a large number of cases the supply can at least keep pace with the waste, and under some circumstances an excess of material may be assimilated. Besides I do not think that the ability of the living cells to take up matter and to fix it can be so seriously impaired in chronic fevers with decided remissions as it is in acute diseases at the height of the fever (see p. 211).

If one supply a normal organism with only so much albumen in the food as is metabolised in fasting, the most ample provision of non-nitrogenous aliment will not suffice to prevent a continuous loss of albumen from the body. This fact appears to me to bear on the nutrition in fever, for it shows that the febrile organism too cannot be satisfied with an amount of

[1] If an animal whose temperature had been for some time maintained at a point above the normal by the escape of heat from its body being prevented is taken from the hot chamber, and after a short time replaced in still higher temperature, that of its body rises less and the symptoms of the elevation are less marked than before. Cf. Rosenthal, 'Phys. d. thier. Wärme,' Hermann's *Handb. d. Physiol.*, vol. iv. 2, p. 447.

albumen equal to that which it metabolises when no food is given, and that the point at which the intake and output are balanced can only be attained by the administration of a much larger quantity of albuminates. One may, indeed, conclude that a smaller quantum of albumen will suffice to save the febrile subject from actual loss of weight if fats and carbohydrates are also supplied than if they are not. But we have not at present any decisive observations on the best proportions of nitrogenous and non-nitrogenous foodstuffs for fever patients. In my opinion the greatest material results will be attained when the proportion of albuminates to the other foodstuffs is so much greater as is the albuminous metabolism in excess of the destruction of fat in the body.

The belief that fever patients require a diet in which albuminates preponderate prevailed long since, especially among English physicians, but without meeting any general approval. The opposite view, that such individuals should receive a food rich in non-nitrogenous substances, enjoyed a far wider recognition, and the teaching of Todd and others, who gave their patients in high fever beef-steaks and alcohol in concentrated forms, was held to be a grievous error. Since I have already repeatedly insisted in the most emphatic manner that the impaired power of digestion in fever calls for a careful selection of the food, and that solid foods cannot be borne by the majority of patients labouring under the acuter forms of fever, the opinion I have thus expressed cannot possibly give occasion to any misunderstanding. I will not on any account sanction the administration of solid foods containing a large proportion of albumen, and I also hold that an exclusive use of albuminates is undesirable; still I believe that in fever a larger proportion of albuminates is requisite than in health, and so much larger as the albuminous metabolism is greater.

I am well aware that it is somewhat injudicious to advance views that are not adequately supported and may yet give occasion to practical consequences. But if one look more closely into the principles of fever diet, as now accepted by the majority of authorities, we shall find that they are not in glaring opposition to the doctrine that fever patients need a highly albuminous diet. The idea that the waste of tissue in fever demands especially the administration of non-nitrogenous foods is never at any rate pushed to an extreme, and of late considerable attention has been given to supplying fever patients with dishes and preparations containing albumen in forms most easily digested and directly absorbed. But the old experience that decoc-

tions of groats, rice, and thin meal soups are very well tolerated by febrile subjects in no way proves that one should give little else than carbohydrates; on the contrary, numerous observations have shown that a highly albuminous diet may be supplied in fever without injury if it do not make greater demands on the digestive powers than do gruel and barley water.

Diet in Acute Febrile Diseases.

Since the conditions which regulate the quantity and the choice of foods in fever vary greatly it is clear that no rules of general application can be laid down; one must in each single case carefully balance the several circumstances, especially the duration of the disease, the strength of the patient, and the state of the organs of digestion. The general principles of diet which can be deduced on the one hand from experience, and on the other from our knowledge of the animal economy, will find a right application only when the indications given in each case are exactly ascertained.

If an acute febrile disease run its course within a few days there appears, as a rule, no necessity for the administration of any special amount of nourishment, unless we have to deal with an individual in whom a few days' abstinence may induce considerable weakness, as is sometimes the case, for example, in extreme old age. Besides it is decidedly advisable to prescribe a rigidly spare diet when the appetite is greatly reduced and marked symptoms of febrile dyspepsia are present.

There are several appropriate relishes and stimulants which are generally given to such patients, while the total quantity of food has to be reduced to a very small bulk. To the former class belongs clear broth which may be made more palatable by the addition of meat extract. Tea and coffee are luxuries the deprivation of which is, as a rule, painfully felt by such as are accustomed to their use. The infusions, however, should not be concentrated, and in great irritability of the gastric mucous membrane tea should certainly be withheld, while coffee not unfrequently causes a sense of weight and burning in the stomach and strong peristaltic movements. By the addition of milk and sugar these beverages become foods without their being in any degree less well borne.

As foods in the narrower sense soups made from the meal of the cereals have from the earliest times been in great repute for fever patients, and no doubt are well suited for the purpose by their digestibility, although from the small amount of food-stuffs, especially of albumen, which they contain they can serve as the sole or chief article of food in those cases only where a rapid reduction of strength or a long duration of the disease is not apprehended. Most used are the mucilaginous decoctions of groats, barley, or rice, which should be rubbed through a sieve and not flavoured with any irritating condiments.

According to Renk's analyses of the diet of the General Hospital at Munich a ration of pearl barley soup contained on an average in 315 grammes 2·8 grammes of albumen, 2·8 grammes of fat, and 17·9 grammes of carbohydrates; one ration of rice soup, 2 grammes of albumen, 1 gramme of fat, and 19 grammes of carbohydrates (see p. 176). The straining off of the solid residue of course materially diminishes the strength of the decoction.

Uffelmann has asserted that in the preparation of the soups of the cereals 1 part out of 5 or 6 of the water is boiled away, so that in 100 parts of meal soup one may reckon on an average the albumen at 1·6 to 2 and the carbohydrates at 12·5 to 15. At the same time it is to be observed that such soups when too thick less palatable and also inferior in digestibility to the thinner.

For a number of cases the fruit soups, made by boiling fresh or dried fruits with water, with or without the addition of sugar, lemon peel, &c., and freed from the solid residue by pressure, are an agreeable and useful change; but one must not forget that the proportion of nutriment in these is very small.

According to the directions of Uffelmann to prepare a fruit soup 1 part of fruit and 4 or 5 of water should be taken. Thus in 100 parts of soup made from, say, fresh apples there would be 0·1 of albumen, 3·2 of carbohydrates, and 0·2 of free acid (see p. 66) if no sugar have been added. Such preparations must be looked on as little more than luxuries, although the presence of organic acids in fruits renders them specially suited for fever drinks. There are also the sweet fruit soups, such favourites in daily life throughout North Germany, but in general less acceptable to the South German taste.

With regard to all these the previous habits of the patient should be taken into account.

If a fever patient be allowed, besides tea or coffee with milk and sugar, only clear broth or *Schleimsuppe*, without any further addition, the whole daily amount of foodstuffs cannot exceed about 8 grammes of albumen, 6 grammes of fat, and 57 grammes of carbohydrates,[1] while the diet of a normal man not engaged in work should, according to Voit, contain 85 grammes of albumen, 30 grammes of fat, and 300 grammes of carbohydrates. The loss which the body of a fever patient must suffer on a daily diet restricted to *Schleimsuppe*, coffee, clear broth, &c., cannot but be serious, the more so as the metabolism in fever exceeds that of the healthy organism at rest and taking the same above-named diet.

Also in the early days of those febrile processes which give indications of a probably long duration a somewhat meagre and restricted diet is to be recommended, limited to the few simple articles of food or relish just enumerated. Only by degrees may one give larger quantities of food. A very strict regimen is, on the other hand, demanded whenever there is evidence of derangements of the digestive organs, as gastric or intestinal inflammations. Under such circumstances even the total withholding of food may be necessary for a time, and great care must be taken to limit the diet to the quantity of fluid really necessary.

The demand for a larger amount of foodstuffs, and especially of albuminates, in prolonged fever is to a certain extent met by the administration of larger quantities of the same harmless foods and relishes, and where possible by increasing the proportion of albumen therein. For the attainment of this last aim it is usual to substitute so-called strong soups, i.e. decoctions of veal and other highly gelatinous materials. By the addition of gelatin in proper proportion the nutritive value of the soup is greatly increased, without the risk of imposing

[1] According to Renk's estimate—

	Albumen	Fat	Carbohydrates
1 ration of coffee with milk and sugar .	4·1 grms.	3·9 grms.	19·2 grms.
2 rations of rice soup of 281 grammes .	4·0 „	2·0 „	38 0 „
	8·1 „	5·9 „	57·2 „

any further burden on the digestive organs. Instead of clear broth one may use beef tea, which always contains a certain amount of albuminous matters. The supply of albumen can be raised step by step by adding suitable quantities of succus carnis, Leube's meat solution, or other peptone preparations.

The *infusum carnis frigide paratum*, from the very small percentage of albumen it contains (1 per cent.), presents little advantage for this purpose (see p. 86). Of the other preparations named, Leube's soluble meat can be most recommended, since besides peptone it contains some unaltered albumen, and is taken by invalids without much reluctance. Each tin, as met with in the shops, contains 250 grammes of fresh meat, or 8·5 grammes of nitrogen, so that in taking the contents of one during 24 hours a considerable quantity of albuminous matter will have been ingested.

Buss has in a manner carried to perfection the principle that so far as possible all food should be given to fever patients in the liquid form, by devising the following mixture of peptone and grape sugar with the addition of rum or cognac:—100 grammes of flesh peptone from the manufactory of Sanders Ezn at Amsterdam, 300 grammes of grape sugar, and 200 grammes of rum or cognac are diluted by the addition of about 600 grammes of water. This quantum must be consumed in the course of 24 hours at suitable intervals, each dose being diluted with an equal volume of water. Many patients find the sweet taste of the solution disagreeable, so that the addition of 2 to 3 grammes of extract of gentian is often necessary. Vomiting rarely follows, although the peptone preparation leaves much to be desired on the score both of taste and smell. Besides this his patients receive bouillon or *Schleimsuppe*, or soup with yolk of egg and milk (1 to 2 litres daily). Under such a course of feeding it was shown that typhus patients lose very much less than Jürgensen found with his, though liberally fed with milk, soup, and eggs.[1]

The food employed by Buss is remarkable for the large percentage of albumen, ample enough, it would seem from the prescription, to maintain the constitution of a healthy man.

The fact that it has not yet been found possible to give to

[1] The notion that the ingestion of large quantities of grape sugar—that is, of the commercial glucose—would cause diarrhœa and gastric catarrh as a consequence of abnormal decomposition of the sugar is, according to Buss's experience, groundless. Even if in some cases frequent watery evacuation occurred a single dose of tinct. thebaica quickly removed the trouble. See C. E. Buss, *Ueber Wesen und Behandlung des Fiebers*.

such peptone preparations, succus carnis, &c., even a tolerably agreeable taste stands in the way of their more general adoption quite as much as the question of price; the demand for agreeable gustatory sensations and for variety cannot be long repressed, and when the sick man is compelled to take food to which he has at the time a decided aversion severe dyspepsia, vomiting, &c., may ensue.

In the majority of cases we are not precluded from giving the fever patient a larger quantity of the foodstuffs, and even of achieving a certain variety by the use of natural and palatable foods. The most important of these are undoubtedly milk and eggs, which, though it is true that they cannot be absorbed without the help of the gastric juice, are as a rule very well borne and utilised if only certain precautions are observed in their administration. At the same time the soups may, by the addition of various appropriate materials, be made the vehicles of a large amount of nutriment, and also give a variety as regards flavour to the diet.

Among the most important precautions to be observed in the feeding of fever patients, and on which especially depends the digestibility of milk, eggs, &c., is the rule only to give small quantities at a time, and to withhold nourishment for short intervals only. Under some circumstances it may be expedient to give fluid nourishment every hour after the manner of a medicine. In this way any overloading of the stomach will be avoided, and the milk will not form those large and tough curds which present a greater obstacle to digestion than finely divided coagula. Besides it is more reasonable to introduce into the nutrient fluids small quantities of materials for metabolism at frequent intervals than to flood them as it were with foodstuff two or three times a day, since metabolism must thus be carried on more regularly. Yet one must not neglect the advice of Liebermeister and Buss to utilise specially for the administration of food the periods of remission, be they natural or artificially obtained.

The fever diet in ordinary use in the General Hospital at Munich consists of—

	Albumen	Fat	Carbohydrates
Quarter diet with egg	20·3 grms.	17·7 grms.	23·5 grms.
Half a litre of milk	20·4 „	19·4 „	21·0 „
And one egg	6·3 „	4·9 „	—
Total	47·0 „	42·0 „	44·5 „

If required two eggs and a larger allowance of milk are ordered, or a second portion of coffee in the afternoon. If the proportion of carbohydrates must be increased a thick decoction of rice, barley, sago, or the like is substituted for the custard.

Such a diet, notwithstanding its relatively high proportion of albuminates, is very well borne by many, though of course not by all, patients with long-continued fever, and even larger quantities of the foodstuffs may be taken in many cases without injury. Thus Renk gave a typhoid patient for twenty-one days on an average daily $\frac{1}{4}$ diet with egg, $\frac{3}{4}$ litre of milk, $\frac{3}{4}$ litre of beer, 2 eggs, 150 grammes succus carnis, and 1 ration of brandy and egg mixture, and observed that the patient wasted very little in spite of high fever and diarrhœa.[1] The eggs were given either lightly boiled or beaten up in bouillon. He thus received daily 91 grammes of albumen, 76 grammes of fat, and 100 grammes of carbohydrates, and it was remarkable that the patient took the whole without any reluctance. This observation may serve as one example among many to show that one may in a large number of cases of high fever give a considerable amount of nourishment with evident advantage, although both the quantity and the quality must be regulated by the state of the patient's digestive organs for the time.

I am far from expecting all possible benefit in the treatment of fever to be derived from a judicious dietary, but I see in it a powerful means of protecting the body from needless waste and of giving it a greater power of resistance, though always under the supposition that the administration of food will not be from a one-sided standpoint or on a rigid pattern, but regulated by a careful consideration of the circumstances of each case.

Besides the articles of food, &c., already described there are a number of preparations which may under certain circumstances be of great service for the use of fever patients. So in those cases in which cow's milk cannot be tolerated even in small

[1] The well-known brandy-egg mixture is very often given in cases of marked weakness. It is made with 100 grammes of cinnamon water, 50 grammes of cognac, 50 grammes of syrup of orange peel, and one or two yolks of eggs.

doses and diluted, it may be replaced by surrogates, among which Nestlé's infant's food and similar preparations or Liebig's food for children are very well suited to the purpose. Chocolate too, fine and as free as possible from spices, or cacao deprived of its fat and boiled with milk, will be well borne by most sick persons. Jellies, so called calf's-foot, &c., enjoy a high reputation among many physicians as a suitable food for fever patients, and it must be admitted that they can be made very palatable and are easily borne provided the patient manifest no aversion to them. Of less nutritive value, but very agreeable in taste to most fever patients, are the fruit jellies and fruit ices, which last are often of great service where there is much irritability of the stomach.

While up to the present time some doubt exists as to the importance of the administration of food in fever, and still more as to the extent to which it should be carried, there is a complete unanimity among all authorities that the sense of thirst must be relieved by an adequate supply of drink. The choice of a suitable beverage is attended by no difficulties, for good potable water cannot hurt anyone, and if needed it can bé flavoured by sugar or sweet fruit juices or an egg beaten up in it. When good drinking water is not to be had it can be replaced by natural Seltzer, Apollinaris, or other mineral water.

There are too the mucilaginous decoctions of barley, salep, or highly boiled rice, which have always been in favour as fever drinks, and in fact they are very useful when diarrhœa is present, but should not be persevered in if the patient feel a repugnance to them.

Milk of almonds appears to me less to be recommended than these mucilaginous decoctions. Acidulated drinks, and especially lemonade made with lemons, sugar, and water are, on account of their refreshing and cooling effects, very suitable, but when there is much diarrhœa they are better avoided.

Formerly there was a widespread opinion that alcoholic drinks must, from their 'heating' properties, lead to an increase of fever. Numerous observations have, however, shown that alcohol exerts no elevating, but often a depressing action upon the temperature of the body, and since that time the use of alcoholic drinks has become almost general in fever. At the

same time the power of alcohol to lower the temperature does not enter into the question, since it is not exerted by small doses; wines, &c., are given rather as stimulants; alcohol also induces certain material effects in the body, which may perhaps contribute to the explanation of its favourable effects in fever (see p. 69).

Among the different alcoholic drinks wine is to be preferred, and the height of the fever is no obstacle to its use unless when structural changes are present in the brain or one has to contend with a hæmorrhage. In general one would do well to give but moderate doses of the lighter wines so long as a powerful analeptic effect does not seem necessary; then, as Liebermeister has very well urged, it is still in one's power to rapidly and greatly increase the dose should symptoms of failing strength supervene. In ordering wine the previous habits of the patient must be taken into consideration, for on this it must partly depend what doses shall be given and whether diluted or not.[1]

Strongly alcoholic wines and concentrated spirits should be had recourse to only when it is necessary to stimulate the heart to energetic action and to obviate a tendency to asthenia. Though in fever there seems to be a great tolerance of alcohol one often observes after too large doses of concentrated spirituous drinks an increase of restlessness and irritability followed by a degree of stupor (Uffelmann). It must also not be forgotten that the continued use of alcohol in concentrated forms is unfavourable to the activity of the digestive organs.

Persons who are used to a regular allowance of beer often prefer it in sickness to wine. In favour of beer it must be admitted that it is not merely a stimulant, but also contains a certain amount of nourishment, and that it is much less expensive than wine. In many cases beer may be allowed without hesitation, but if commencing disorders of the digestive organs are suspected it would be better to refrain from the use of this beverage.

[1] In the General Hospital at Munich 150 to 300 grammes of a light red wine are generally given to a patient with severe fever, or if preferred the like quantity of white wine may be ordered.

Diet in Chronic Febrile Diseases.

If an organism receives an insufficient amount of nutriment it draws on its own tissues until an equilibrium is established between its intake and output, or death supervenes before this equilibrium is attained if the amount of nutriment is so small that the tissues are subjected to a loss incompatible with the continuance of life. The sufferer with chronic fever must succumb after the lapse of weeks and months of wasting if the body lose weight continuously; in such cases therefore the supply of food should be so regulated that the intake at least cover the loss. In acute febrile diseases we must neglect the maintenance of the bodily condition, and can do so without hesitation, since a loss of substance, if not too great, is of no permanent injury to the organism; the purposes of food in such cases—viz. averting danger to life, counteracting a too rapid destruction of the tissues, and maintaining the organs in as functionally active a condition as possible for a certain limited time—all these can be effected without covering the waste of the body.

But in the dietetic treatment of chronic febrile states, when we have to do with persons already greatly reduced and emaciated, we do not aim at simply maintaining the present condition, but must strive in every way to improve the state of nutrition and to increase the body weight. Daily experience teaches us that an improved state of nutrition exerts in many cases a favourable influence on the morbid process itself: this is especially the case in pulmonary phthisis, and also when we seek the absorption of chronic exudations, &c.

An increase of substance is only conceivable when the assimilation of nutriment exceeds the waste of tissue, and it is quite possible for persons with chronic fever to take up so much provided the intensity of the fever is not too great and the digestion is strong enough for the work. The higher and more continuous the fever the smaller is the probability of such a result being achieved, while regular remissions or intermissions are in many ways favourable to an accession of substance (see pp. 192, 193, and 223).

It not unfrequently happens that patients with chronic

fevers are unable to bear a diet requiring a fair digestion, so that a rise of the fever and well-marked gastric and intestinal disturbance, as vomiting and diarrhœa, set in. If such patients even entertain a decided repugnance to food, as they often do, it is generally useless to hope for much success. Under these circumstances one is driven to the use of liquid food almost exclusively, and can at the most endeavour by this and that savoury and tempting dish to stimulate to some extent the flagging appetite of the invalid.

In contrast with such one meets with many persons suffering from chronic fevers who can without much effort take and digest well any quantity of solid food. One not unfrequently sees phthisical patients who consume the full hospital diet without any visible ill effects, although their evening temperature oscillates between 39° and 40° C (102° to 104° F.). With such patients one need feel no anxiety as to the choice of foods provided their nutritive value be the same. Between these two extremes, the utter loss of appetite and digestion on the one side and the expressed desire for a liberal diet on the other, there is of course every possible gradation, with which the difficulty of feeding both as regards quantity and quality varies accordingly.

Whether the digestive functions are much or little impaired will determine the choice of foods, but in every case one must bear in mind that in each article of diet the foodstuffs must be present in those relative proportions which under the given circumstances appear best adapted to save the body and to ultimately effect an increase of flesh.

The question of what is the best proportion of the foodstuffs in chronic fevers to check the wasting as far as possible is very much discussed. The old physicians were of very different opinions as to the composition of the food for such patients, and to the present day theoretical opinions and practical experiences are urged in favour of a highly albuminous diet on the one side and of the fat and carbohydrates on the other.

If one keep in view the influence of the various foodstuffs on metabolism as well as on the increase of albumen and of fat in the normal organism, it will be to a certain degree self-evident that a continued administration of one class, whether nitrogenous or non-nitrogenous, is not calculated to contend

successfully with the advancing emaciation of chronic fevers. Doubtless those physicians who maintain that a liberal and mainly flesh diet tends to accelerate the wasting in phthisis are in the right. It is also conceivable that the administration of fats or a suitable combination of farinaceous foods and milk may much oftener be successful in arresting the emaciation or even in leading to a gain of weight than can a diet in which meat is present in excess. But such observations by no means prove that a vegetable diet poor in nitrogen is to be preferred; they only show that a highly albuminous diet acts unfavourably, which is not to be wondered at when we reflect that even under normal conditions the human organism cannot long be maintained on a purely flesh diet.

In the treatment of chronic febrile diseases, and especially of pulmonary consumption, great stress has always been laid on diet. The observations collected in course of time often labour under the defect of not giving sufficient attention to the relative proportion of the several foodstuffs in the diet. In the earlier ages the chief distinction was drawn between animal and vegetable foods, and men came to the conclusion that the latter were better calculated to check the emaciation of phthisis than the liberal use of meat, eggs, &c. Milk, however, has from the earliest times been held to be the best and most valuable food for consumptives.

At one time the albuminates were believed to be essentially nutritious, while fats and carbohydrates were supposed to serve solely for the maintenance of respiration and the development of heat. Under the influence of this idea a liberal supply of albuminates was held by many to be necessary in order to improve the depressed nutrition of phthisical patients. But the one-sided administration of albuminates without the addition of a corresponding amount of fats and carbohydrates could not fail to produce in a short time injurious consequences, which led many physicians to the conclusion that a 'nutritious' diet was not suited to such patients, and it became a principle that the wasting of phthisis was to be combated mainly by fats and carbohydrates.

That many erroneous views as to the diet of chronic fevers have arisen from a defective knowledge of the action of the several foodstuffs and their combinations I think I can best prove by giving the opinions expressed by Traube on this subject. According to this observer the administration of food in acute febrile diseases must be directed to combating the threatened loss of strength far more than

the emaciation. On the other hand in chronic and subacute morbid processes when the first high febrile stage is past one should aim at securing a gain of weight. A too early use of a nutritious and stimulating food in these cases is, in his opinion, a dangerous mistake, since under such circumstances it can only lead to a still more rapid emaciation.

In illustration of this view Traube quotes an example from his own practice, that of a young man in a somewhat advanced stage of pulmonary consumption, who, in spite of a liberal allowance of beef steaks, cutlets, and eggs, continued to lose weight. At Traube's direction the management of the case was completely changed and a more vegetable diet prescribed, when the patient, notwithstanding the poorer (?) diet, at once began to gain flesh.[1]

It is clear that in this case a gain of flesh could not have taken place unless the assimilation of nutriment had not exceeded the waste, but in the presence of fat and carbohydrates a smaller amount of food produced greater results than a larger, but one which included an excessive proportion of meat.[2]

The necessity for an adequate allowance of food in pulmonary consumption with fever was strongly insisted on by F. v. Niemeyer. In his opinion those foods are the most suitable which contain a large amount of fat or fat-formers, but a relatively small proportion of albuminates. According to Niemeyer such a choice is justified by the fact that 'with a liberal allowance of proteids the excretion of urea, and therefore the metabolism of the albumen of the body, is increased. On the other hand an equally liberal allowance of fat and fat-formers diminishes the waste of those organs and tissues which are of far the most vital importance to the organism. Thus for phthisical patients the largest possible consumption of milk is to be urgently recommended. It is, however, quite unnecessary—indeed, the reverse—that the casein should be removed and the whey alone drunk, unless it should be found, which it very rarely is, that whey is well but milk ill digested by the patient.[3]

Experience and theory agree in teaching that a continuous loss of flesh in chronic febrile disease can be avoided, and a gain achieved, only by a combination of nitrogenous and non-nitrogenous foods ; yet it is not ascertained what are, under

[1] L. Traube, *Die Symptome d. Krankheit des Respirations- u. Circulations-apparats.* Berlin, 1867.

[2] Compare H. Brehmer, *Die chronische Lungenschwindsucht.* Berlin. 1869.

[3] F. v. Niemeyer's *Klinische Vorträge über die Lungenschwindsucht*, communicated by Dr. Ott. Berlin, 1867

what circumstances, the most eligible proportions of albumen on the one hand and of fats and carbohydrates on the other. In normal conditions the sensation of hunger and of general comfort decide what quantity of each foodstuff is desirable. With the sick, on the contrary, such sensations are, as a rule, untrustworthy, and consequently cannot be turned to account in the selection of an appropriate diet. Besides, in their case the functional activity of the digestive organs must be economised, whence it seems desirable that the administration of food should be so conducted that the greatest possible material results shall be attained by the smallest quantity of food. Lastly, it is of great importance whether any particular mixture of foods produces an increase of albumen, or of fat, or of both, and it is only with great hesitation that a regimen should be followed which leads only to an accumulation of fat in the body.

The view put forward by many physicians that in chronic febrile diseases the fats and carbohydrates should be especially supplied does not accord with the scarcely disputed experience that looks on milk as the very best food for such individuals. Cow's milk, indeed, does not constitute a sufficient diet for healthy adults, since it contains too small a proportion of non-nitrogenous bodies relatively to the albumen present, the nitrogenous being to the non-nitrogenous constituents nearly as 1 : 3. If, then, a person suffering from chronic fever take large quantities of milk, he receives a highly albuminous diet, and one that under normal circumstances would call for a further addition of fat and carbohydrates. It would be very interesting to obtain exact statements of the composition of the diet provided at well-conducted institutions for the treatment of consumptives, and especially of cases attended with fever. I presume that in most cases the diets approved by experience would be found to contain a larger amount of albumen in proportion to the fats and carbohydrates than that of a healthy working man. Beneke has stated that in the institutions the diet sheets of which were examined by him the proportion of albumen was highest in the Hospital for Consumption (Brompton), where it was 1 : 4.

It is clear that a diet consisting mainly of meat and milk would not present a proper admixture of foodstuffs unless

supplemented by a certain amount of non-nitrogenous matters, some of which should, as long experience has shown, be in the form of fat, a circumstance which may among others have suggested the use of cod-liver oil.

That the use of large quantities of fats by patients with sensitive digestive organs requires much caution has been insisted on by many physicians; Brehmer remarks on this that patients often, acting on the principle 'Much does much,' indulge in excessive amounts of fat. In those cases in which the administration of fat foods, cod-liver oil, &c., causes dissatisfaction they should be replaced by a corresponding amount of carbohydrates.

Brehmer and others attach much importance to the employment of a certain quantity of wine in the treatment of consumption, and the Hungarian wines are in special repute. How far the beneficial effects of wine may be referred to their power of saving tissue waste we have at present little evidence.

The fact that milk appears to be specially useful in checking the emaciation of phthisis is not sufficient to indicate the proportion in which albuminates and carbohydrates exist in it as the best proportion to be followed in the other food. In favour of such a diet, however, we must admit that in chronic fever the albuminous metabolism is raised, though not to the same extent as in acute fevers, while the consumption of fat is but little, as, among other things, the fatty degeneration of organs not unfrequently met with shows. Thus it appears that relatively to the proportion of fat and carbohydrates more albumen is required in phthisis than in health to avert a loss. It cannot be expected that the conditions for the increased albuminous metabolism of fever should be removed by the supply of fat and carbohydrates; for this purpose a certain quantity of albumen is absolutely necessary. An organism suffering from chronic fever would presumably perish even in spite of the most liberal provision of fat and carbohydrates, if only so much albumen were contained in the food as is metabolised in starvation.[1] The prolonged consumption of albumen in fever can, according to this view, be met only by a corresponding increase of albuminous food, while probably a relatively smaller proportion of non-nitrogenous nutriment suffices to

[1] Cf. *Luxusconsumption*, p. 17.

maintain the body, and so far to keep the albuminous metabolism within bounds as to balance the greater activity of metabolism inseparable from an increased ingestion of albuminates.

After all, the question of the best relative proportion of nitrogenous and non-nitrogenous aliments in chronic fevers must still be regarded as an open one, which can only be definitively answered by more precise experiments on the mode of action of their various combinations in patients of this class.

Quite recently M. Debove has published a report on several cases of far advanced pulmonary consumption in which he achieved favourable results by 'forced nutrition.'[1] Proceeding from the fact that the absence of appetite and repugnance to food shown by many patients made a sufficient alimentation well-nigh impossible, and also led to the food taken being but ill digested, M. Debove put the question to himself whether these difficulties could not be got over by the introduction of the food directly into the stomach by means of a tube; for it does not follow that in the sick want of appetite and feeble digestion should always run parallel, and a certain power of digestion may be present with absence of appetite. By way of experiment he gave to an extremely reduced phthisical patient, with total loss of appetite, diarrhœa, &c., after he had washed out the stomach by means of a stomach pump, a litre of milk, and on each of the following days two litres of milk, 200 grammes of raw scraped meat, and 10 eggs.

According to the statement of M. Debove the food thus introduced directly into the stomach in the quantities given was well tolerated and digested, and almost immediately produced a marked improvement in the nutrition of the patient and in the more prominent symptoms of the disease.

One would, however, often hesitate at employing this method of 'forced feeding,' although it must be admitted that the experiments of M. Debove are in several respects not without interest.

DIET IN CONVALESCENCE.

When an organism has, in consequence of disease of greater or less duration, suffered the loss of a certain proportion of its constituent elements, these can only be replaced by a supply of nutriment sufficient to restore the functional activity

[1] M. Debove, 'Du Traitement de la Phthisie Pulmonaire par l'Alimentation Forcée.'—*Union Méd.*, 3rd series, 1881.

and resisting power of the body. If one has to do with febrile diseases that have run their course the return of the normal temperature marks the point at which one must turn one's attention to the gradual restoration of the lost constituents of the body.

In many cases the loss of weight continues for some time after the cessation of the fever, and that from a variety of causes. When the albuminous metabolism is prolonged after the subsidence of the fever the possibility of taking nourishment at the commencement of convalescence is still limited, and the full recovery of functional power of the digestive organs returns but gradually. In consideration of this last-named circumstance it appears advisable that, at the commencement of convalescence, especially from long-continued disease, the greatest attention should be given both to the choice of the food and that the quality and quantity shall be suited to the state of the patient's digestion for the time being. The return of the digestive functions to their normal activity proceeds differently in different cases: in some it is slow and interrupted, so that one has long to contend with want of appetite; in others a natural hunger appears very early, and great caution has to be exercised in such cases to avoid mistakes both as to the quantity and quality of the food. It must be remembered that persons who have been much reduced are, even when they feel a strong sensation of hunger, by no means in a position to digest or assimilate large quantities of solid food.

The greatest caution is demanded when convalescents who have for a long time subsisted entirely on fluids gradually resume the use of solid food. It has already been shown that at such a time various forms of indigestion and a rise of temperature, of longer or shorter duration, are very prone to follow errors in diet, especially the use of foods which such patients are as yet incapable of digesting. That this should be specially the case with meats, is easily intelligible if one assume that they irritate the sensory nerves of the mucous membrane of the digestive organs more than vegetable foods do, and thus, as well as by their rapid passage into the nutrient currents, they induce an increased action of the heart, a condition of

congestion, &c. That such is possible cannot be disputed, but in my opinion the chief stress should be laid, not on the animal or vegetable origin of the food, but on its consistence. One should then always take care to effect the transition from fluid to solid foods by means of semisolid milk and farinaceous preparations, and to give the meat at first in a finely divided form, as mince, rasped bacon, &c.[1]

With feeble convalescents in whom the return of the appetite is long delayed it is fortunate if one can discover some particular dish so suited to their taste as to be devoured with relish. No general rules can be laid down in this respect, since tastes are so diverse, but it is scarcely necessary to remark that if decidedly perverse cravings are manifested they should not be complied with.

In the dieting of convalescents it is of importance to bear in mind that they are, as a rule, persons in that reduced state in which a much smaller amount of nourishment suffices for the maintenance of the body than would be required by a well-nourished organism. It is, therefore, not necessary, in order to achieve an increase of weight, that one should, under such circumstances, give any large quantity of food from the first; on the contrary it should be very gradually increased. The restoration of the wasted tissues proceeds but slowly, and

[1] Many authorities maintain that an error of diet in a convalescent from enteric fever may bring on a relapse. I cannot assent to this view, having not unfrequently observed that after a cessation of the fever of longer or shorter duration the temperature has again risen before any error in diet could have been committed. Often, however, the patients have already begun the convalescent diet, which they are then unable to digest, so that the symptoms of a dietetic error supervene. See *Annalen d. städt. allg. Krankenhäuser zu München*, vol. i. p. 92, 1878.

[These differences of opinion and apparently discordant results of experiences are probably in great part, if not wholly, attributable to a neglect to clearly distinguish between mere febrile disturbance due to acute gastric catarrh, recrudescence of the fever itself, and true relapses occurring after the disease has run its course and the temperature has become normal. The first may obviously be caused by errors in diet quite irrespective of the previous disease; the second may be so, just as diptheria may be aggravated or prolonged indefinitely by irritation of the mucous membrane of the pharynx; but that the third should be thus brought about, i.e. that the entire cycle of phenomena of a specific disease should be repeated, is in the highest degree improbable. The whole question was worked out by the late Dr. Pearson Irvine.—TRANSLATOR.]

is not at all hastened by the ingestion of large quantities of food, since of an excess of nourishment only a fraction is stored up in the body, the remainder being submitted to metabolism, the activity of which rises with the increased ingestion of food. How slowly the replacement of the albuminous constituents lost during a long febrile disease may be performed is shown by the following course of observations by Renk, recording the intake and output of nitrogen by a typhoid patient for twenty consecutive days :—

Day of Observation	Evening Temperature	In the Food		Nitrogen in Urine	Difference of the Nitrogen	Loss or Gain of Albumen after allowing 2 grms. Nitrogen in the Fæces
		Albumen	Nitrogen			
1st	39·6	66·0	10·23	15·26	−5·03	−45
2nd	38·4	50·3	7·79	13·76	−5·97	−51
3rd	38·9	45·0	6·97	14·65	−7·68	−62
4th	Normal	43·9	6·80	10·87	−4·07	−39
5th	,,	57·2	8·87	13·86	−4·99	−45
6th	,,	54·4	8·43	14·09	−5·66	−50
7th	,,	84·4	13·08	15·53	−2·45	−29
8th	,,	83·3	12·91	12·38	+0·53	−10
9th	,,	84·1	13·04	10·50	+3·54	+4
10th	,,	80·8	12·52	13·11	−0·59	−17
11th	,,	77·5	12·01	11·55	+0·46	−10
12th	,,	73·0	11·32	9·47	+1·85	−1
13th	,,	68·1	10·56	7·89	+2·67	+4
14th	,,	101·4	16·38	11·72	+4·66	+17
15th	,,	140·9	21·84	11·78	+10·06	+52
16th	,,	109·1	16·91	12·83	+4·08	+13
17th	,,	99·4	15·41	9·24	+6·17	+27
18th	,,	100·3	15·55	9·58	+5·97	+25
19th	,,	108·8	16·86	11·24	+5·62	+23
20th	,,	89·5	13·87	11·27	+2·60	+4

The quantities of albumen in the different foods administered are shown in the following tables. The figures indicate grammes of each:—

First Day :	Albumen
1,000 milk	40·8
500 broth	—
4 eggs	25·2
	66·0

Second Day :	
770 milk	31·4
500 broth	—
3 eggs	18·9
	50·3

Third Day :	Albumen
750 milk	30·6
520 broth	—
15 toasted sippets	1·8
108 light pudding	12·6
	45·0

Fourth Day :	
750 milk	30·6
508 broth	—
114 light pudding	13·3
	43·9

Fifth Day:

	Albumen
750 milk	30·6
53 roll	5·0
22 sippets	2·6
201 mince	18·0
Half a dumpling	1·0
530 broth	—
	57·2

Sixth Day:

750 milk	30·6
63 roll	6·0
552 broth	—
126 brains	14·0
132 sauce	1·0
24 sippets	2·8
	54·4

Seventh Day:

123 roll	11·5
750 milk	30·6
305 panadel soup	4·8
360 semolina „	3·7
106 prepared veal	18·8
148 sauce	1·1
230 macaroni pudding (Mus)	13·9
10 sugar	—
	84·4

Eighth Day:

750 milk	30·6
138 roll	13·2
343 macaroni soup	4·0
106 veal	18·8
132 sauce	1·0
16 sippets	1·9
230 rice pudding (Mus)	13·8
10 sugar	—
297 broth	—
	83·3

Ninth Day:

750 milk	30·6
143 roll	13·7
166 rice soup	1·4
273 semolina soup	3·1
255 brains	28·0
103 dumpling	5·3
343 sauce	2·0
5 sugar	—
250 beer	—
	84·1

Tenth Day:

	Albumen
500 milk	20·4
143 roll	13·7
323 egg and barley	4·7
87 veal	16·5
150 sauce	1·2
14 sippets	1·7
325 rice pudding	19·0
70 dumplings	3·6
5 sugar	—
	80·8

Eleventh Day:

750 milk	30·6
153 roll	14·7
635 broth	—
52 sippets	6·3
116 veal	22·1
477 sauce	3·8
10 sugar	—
500 beer	—
	75·5

Twelfth Day:

250 milk	10·2
147 roll	14·1
228 savoy soup	2·2
21 sippets	2·6
408 macaroni	32·9
339 custard	10·4
Jam	0·6
10 sugar	—
500 beer	—
	73·0

Thirteenth Day:

250 milk	10·2
153 roll	14·7
337 Vermicelli soup	4·8
247 Strudel[1]	19·8
Jam	0·6
339 panadel soup	5·6
345 semolina „	12·4
10 sugar	—
500 beer	—
	68·1

Fourteenth Day:

250 milk	10·2
141 roll	13·7
317 panadel soup	5·2
301 custard	9·2
242 beef	61·1
169 sauce	2·0
280 potatoes	4·0
10 sugar	—
	105.4

[1] [Strudel is a South German baked pudding made with flour, eggs, milk and *yeast*.—TRANSL.]

Fifteenth Day:

	Albumen
750 milk	30·6
173 roll	16·6
353 macaroni soup	4·9
276 carrots	3·7
144 beef	35·7
285 custard	8·7
175 roast veal	40·7
10 sugar	—
500 beer	—
	140·9

Sixteenth Day:

	Albumen
500 milk	20·4
134 roll	12·9
309 custard	9·4
229 beef	57·8
270 kohl rabi	3·1
306 semolina soup	3·5
173 sauce	2·0
10 sugar	—
750 beer	—
	109·1

Seventeenth Day:

	Albumen
164 roll	15·7
500 milk	20·4
349 egg and barley soup	5·0
118 beef	29·8
256 cabbage	3·6
309 custard	9·4
332 rice gruel	15·5
10 sugar	—
750 beer	—
	99·4

Eighteenth Day:

	Albumen
150 roll	14·4
250 milk	10·2
569 custard	17·1
133 beef	33·4
258 spinach	4·3
79 veal	18·8
190 sauce	2·1
10 sugar	—
750 beer	—
	100·3

Nineteenth Day:

	Albumen
146 roll	14·1
250 milk	10·2
349 savoy soup	4·0
141 beef	35·5
284 Erddotschen	3·4
198 custard	6·0
180 roast veal	35·6
10 sugar	—
780 beer	—
	108·8

Twentieth Day:

	Albumen
149 roll	14·3
250 milk	10·2
332 custard	10·1
131 beef	33·0
226 spinach	3·8
306 panadel soup	4·9
368 semolina ,,	13·2
10 sugar	—
750 beer	—
	89·5

It scarcely calls for mention that the diet of convalescents in whom an accession both of albumen and fat is required should be composed under all circumstances of nitrogenous and non-nitrogenous foodstuffs. At the commencement of convalescence it appears desirable at once to give such a quantity of albuminates as shall lead to a gain of flesh; this is easiest done by supplying so much non-nitrogenous food or carbohydrates as shall arrest the loss of fat from the body, while the albuminates are so regulated as always to outweigh to a moderate extent those metabolised and eliminated. If in the further course of recovery the quantity of carbohydrates in the food is again increased and fat added, while the doses of albumen are raised in a relatively less degree, there will be an

addition of a large quantity of fat to the body as well as of albumen. One must always avoid a one-sided deposition of fat in the bodies of convalescents and endeavour to bring about a complete restoration of the albuminous part of their constitution, since it is only thus that they will recover possession of their full functional energies.

DIET IN DISEASES OF THE DIGESTIVE ORGANS.

A regular and undisturbed activity of the digestive organs is certainly of great importance to the well-being of man. But for the due performance of the digestive processes a number of conditions must be fulfilled which relate on the one side to the quantity and quality of the ingesta as well as the time and manner of taking food, and on the other to the state of the organs themselves. The individual peculiarities play an important part, one person being able to take without ill effects that which to another would be injurious; but even in one and the same individual certain foods may, under some circumstances, induce disturbance of digestion which at another time may be taken with perfect impunity.

Many cases of so-called dyspepsia are attributable to errors of living, and indeed one has frequently to deal with habitual overloading of the stomach, in consequence of which the act of digestion is prolonged, a fact gradually revealed in various unpleasant ways. The injurious effects of a too heavy diet on the organs of digestion are the more evident when it is associated with a sedentary habit and insufficient bodily exercise, or when at the same time there is an abuse of certain indulgences, as the excessive use of alcohol, tobacco, or pungent condiments.

In another class of cases the dyspepsia depends on irregular habits, as when persons take their meals just when they happen to have the time, one meal hot, another cold, and all as a rule so hurriedly swallowed that due attention cannot be given to mastication: or on the habit of engaging in work involving great mental exertion or a stooping posture immediately after a meal.

Many persons are incapable of undergoing mental effort directly after their principal meal, and when this is enforced it is accomplished at the expense of regular digestion. The main cause of these phenomena may probably be sought in the fact that at the commencement of digestion the vessels are filled with blood, thus inducing a fatigued condition of the brain. But if immediately after a meal an active flow of blood is set up in the brain there will clearly be a deficient secretion of the digestive juices.

A habit of taking food which is faulty, either in itself or in regard to individual peculiarities, leads as a rule not only to functional derangements but sooner or later to anatomical changes, especially developing gastro-intestinal catarrh or a hyperæmic condition of the liver.

In the majority of diseases of the digestive organs, whether produced mainly by injudicious habits or by the ingestion of injurious matters, a suitable diet constitutes one of the most essential conditions for a return of the normal performance of the function. In such states there is frequently an abnormal irritability of the sensory nerves of the mucous membrane, the secretion of active digestive juices is impaired, and the peristaltic movements do not occur with regularity; it is thus clear that every act of feeding may inflict an injury, mechanically or chemically irritating ingesta then especially aggravating the morbid symptoms. Under such circumstances it appears desirable that the organs of digestion should for some time be called into action as little as possible, even to the extent of risking a loss of the constituents of the body. On the other hand cases occur in which the problem of improving the general state of nutrition comes to the front, and must be grappled with along with a consideration of the existing derangements.

Acute inflammation of the stomach and intestinal mucous membrane above all demands a very restricted regimen, and in severe cases of this kind even an absolute withholding of food for some time is the most effective means of bringing about a speedy and certain resolution of these states. As a rule such a prescription meets with little opposition, since most of these patients have already a decided reluctance to take food, every attempt being followed by a severe sense of uneasiness, sickness, or actual vomiting. One has no hesitation in ordering

an 'absolute' diet unless when for other reasons the supervention of dangerous weakness is apprehended, and that is, under such circumstances, best averted by the employment of artificial methods of feeding. As drinks in acute gastritis ice or iced water are best, Seltzer water, or even weak tea;[1] when there is much diarrhœa, mucilaginous drinks and light red wines.

When the intensity of the digestive derangement abates, which as a rule is known by the gradual return of the appetite, the patient must not at once resume his ordinary diet, but should at first be restricted to fluid foods, as tea with milk, thin mucilaginous broths, light-boiled eggs, &c., and only gradually attempt small quantities of more solid food, as rasped ham, minced meat, &c. In milder cases a complete deprivation of food is not necessary, and it is sufficient to prohibit all solids and to allow only small quantities of fluid nutriment. The use of beer in gastro-intestinal catarrh is always most injurious, and even wine is not adapted to those cases in which the gastric digestion is disordered, and especially when there are symptoms of intestinal catarrh.

In chronic gastro-intestinal catarrhs, too, a resolution of the disorder may be expected the sooner the less the energies of the digestive organs are called into requisition, and the less opportunity is given by the ingestion of foods for the development of abnormal putrefactive and fermentative processes, and for the further irritation of the mucous membrane by the products of these decompositions. One must not, however, enforce an extremely spare diet in all cases of hyperæmia of the gastro-intestinal mucous membrane, for occasionally a deterioration of the general nutrition would assuredly aggravate the anomalous condition of the organs of digestion. This holds good notably of the venous stases in the abdominal vessels during catarrhs of the gastro-intestinal mucous membrane, in which the administration of nutriment should be so arranged that digestion and absorption shall be carried on without any repletion of the vessels of the viscera concerned, and with as little as possible

[1] So far as my experience goes, weak tea is very well tolerated as a drink in gastro-intestinal catarrhs, and is at any rate preferable to coffee, which frequently produces a sensation of weight and burning in the epigastrium, and may aggravate existing diarrhœa.

of the excitation of the heart's action attending digestion and absorption. For this end it would be well to maintain such patients in equilibrium with an amount of nourishment such as would support a very moderate bodily establishment both as regards albumen and fat. It seems to be most expedient to so regulate the administration of food that as little internal work as possible be occasioned thereby, and no excessive variations of pressure be induced in the vascular system.

The belief that persons with valvular and other diseases of the heart, with pulmonary emphysema, curvatures of the spine, and similar conditions, should observe great moderation in food and drink has been confirmed by long experience. So long as no failure of the heart's action occurs such persons find themselves most easy while they take only so much food as would be required to maintain a bodily establishment, both as regards albumen and fat, just sufficient for their needs. There are several reasons why a diet chiefly vegetable is under such circumstances preferable to one in which animal foods are in excess. Thus the act of digestion is energetically stimulated by most animal foods, and the speedy passage of the products of digestion into the nutrient currents occasions a marked acceleration of metabolism, whereas with a diet mainly vegetable those phenomena which follow on an active and rapid performance of digestion as well as excessive variations in the activity of metabolism seem to be absent. Obviously the composition of the food should be such as to cover all the material needs of the system without any one foodstuff being present in great excess; and both in the choice of the particular vegetable foods and in their preparation and cooking great care must be taken that they are such as to be easily digested and that too large a portion of the ingesta do not pass away unutilised by the bowel.

If, in consequence of venous stases in the digestive organs or degenerative changes in the substance of the cardiac muscles, failure or insufficiency of the heart's action threaten, other dietetic considerations present themselves, but unfortunately we have as yet scarce any data for this purpose. My own opinion is that a moderate diet is advisable for these patients too; the food also should not be bulky and must be easily amenable to the action of the digestive juices. All these conditions are fulfilled by tender fresh meat, light-boiled eggs, and milk in moderate amount, with the addition of so much non-nitrogenous food, i.e. of carbohydrates, that a moderate in-

crease of the albumen in the body may be induced and the abnormal accumulation of fat in the muscular substance of the heart be counteracted. To this the regular use of a certain quantity of fruit may contribute by maintaining frequent actions of the bowel, which are very desirable for such patients.

Whether these maxims, based in great part on theoretical considerations, could be carried out and confirmed in practice or not future observation must show.

In those forms of chronic dyspepsia which frequently appear as consequences of anæmia and chlorosis a consideration of the cause shows us that we must avoid a too restricted diet. Experience too teaches that a highly albuminous diet is of service in removing the anæmia. The administration of large quantities of carbohydrates would also appear unadvisable in such cases, since these bodies are apt, in dyspeptic subjects, to undergo abnormal fermentative changes with copious formation of gases and acids. The use of fat in considerable amount seems under such circumstances to be in a still higher degree hurtful. On these grounds the albuminates are indicated as the foodstuffs whose ingestion acts least injuriously on the digestive organs, assuming that a judicious selection of albuminous food has been made, and that by suitable preparation and cooking the least strain is put on the digestion.

As regards the choice of meats experience shows that the flesh of young poultry (fowls or pigeons) is the most digestible in affections of the stomach. Next comes veal; and game and beef, if the parts are judiciously selected and carefully prepared, may provide highly digestible meats. In general roasting is to be preferred to other modes of cooking; fatty sauces are decidedly bad. It is also highly advisable that the meat should be very underdone, since the muscle fibres in that state preserve their tenderness. Nor should it be too fresh, though the opposite condition of a high degree of decomposition, such as one frequently finds in game, is still more to be avoided; indeed I have often observed that such meat has been ill tolerated by persons in good health but with not very vigorous digestions.

Those cases of chronic gastro-intestinal catarrh which arise either from previous acute inflammation of the mucous mem-

brane of the digestive organs or from continued faulty habits, the abuse of alcohol, tobacco, &c., call for a strict dietetic regimen. In severe cases of this kind in which the appetite is quite lost, and every act of taking food causes great uneasiness, frequent vomiting, &c., it may for some time be necessary to prescribe an absolute diet. At any rate such patients should be restricted to fluid nourishment, and that only little at a time. Since, too, in chronic dyspepsia any large quantity of the fats or carbohydrates is apt by abnormal decomposition to set up renewed disorders, it is advisable that such patients should be supplied chiefly with albuminous foods, among which milk and eggs lightly boiled or beaten up in beef tea deserve special mention; among artificial preparations Leube's soluble meat is to be preferred to all others. Soups with various additions and ingredients are not very suitable foods for these cases.

When one is compelled to continue the use of such a diet for a long time difficulties, by no means of an unimportant kind, arise. On the one hand the monotony excites gradually aversion and disgust; on the other the insufficient supply of non-nitrogenous foodstuffs must deteriorate the general state of nutrition, and on these grounds one will often see reason to desist from further perseverance in this rigid regimen. One will then allow the patient more carbohydrates, but in the forms of light farinaceous foods and some white bread; one must also provide for a certain degree of variety, and here small quantities of tender vegetables will, as a rule, be highly appreciated.

But while in chronic gastric catarrhs so much stress is rightly laid on the prescription of a diet which shall neither mechanically nor chemically irritate the mucous membrane of the digestive organs, and shall offer the least possible resistance to the action of the gastric and other juices, cases of chronic dyspepsia present themselves in which a perfectly 'unstimulating' diet only aggravates the condition. They are those of so called 'atonic dyspepsia,' in which the action of the stronger stimulants is necessary to excite sufficient activity in the organs of digestion. To take rich soups at the beginning of a meal, to add harmless and not too pungent condiments to

the dishes, to avoid too rich or very solid food, these, together with moderation and a certain careful attention to the digestion, are the principal points to be observed in the diet of such persons.[1]

In ulcer of the stomach it is even more imperative than in gastric catarrh that the diet should be restricted, and all ingesta that could mechanically or chemically irritate the surface of the ulcers must be absolutely prohibited; such patients can therefore take only fluid foods, and of these milk is the best. One must, however, see that the patients take even this carefully and but little at one time, thus avoiding the formation of large tough coagula of casein and the retention in the stomach for a longer time than is necessary of the acid chyme with its corroding action on the ulcerated surfaces. Leube's soluble meat presents just this advantage in ulcer of the stomach, that its constituents are for the most part ready for absorption without any particular action of the gastric juice, so that in giving it there is no long-continued secretion of gastric juice—a circumstance doubtless of no small importance for the healing of the ulcers. But, since the soluble meat contains little else than albuminates, it is advisable to give along with it a certain quantity of carbohydrates, on which account Leube gives his patients at breakfast and dinner some milk as well and several so called *Einbackstückchen*, which must be well soaked before being taken. The soluble meat is best given stirred up in slightly salted broth to which a little Liebig's extract has been added, and must, like all foods in these cases, be taken lukewarm. Since one may give such patients from time to time small quantities of gruel, bouillon with yolk of eggs, and tea with milk, the demand for variety can to a certain extent be met. If after persevering in this diet for fourteen days to three weeks the symptoms of the disease subside, one may by degrees proceed to more solid foods—tender lean meat, soft milk foods, potato purées, &c.

[1] Since in patients with atonic dyspepsia the activities of the digestive organs, the secretion of their juices, and the peristaltic movements come into play only when stimulants of a certain intensity are taken, it is easy to see that milk diets, &c., are not suitable; attention is to be directed rather to providing the most palatable and savoury foods and to a due amount of variety.

As foods most likely to irritate the surface of the gastric ulcers Leube mentions particularly all shell fruits, other fruits, black bread, and potatoes, unless given in the form of purée and very finely divided, also all vegetables containing hard cellulose fibres, hard-boiled eggs, compact pieces of meat, &c.

All acid foods are to be avoided, on account of their chemical action; so also the too free use of condiments and indulgence in alcoholic drinks is to be firmly prohibited. Leube also deprecates the use of gruel made from coarse groats or porridge, since the single grains may set up intense irritation, and it seems the more necessary to insist on this since these preparations are very often held to be well borne.

In severe cases of gastric ulcer in which milk and other foods well recognised as among the lightest cause pain and vomiting, and in all cases of copious hæmorrhage, it appears prudent not to call forth the efforts of the stomach at all for some time and to put the patient on an absolute diet. A perilous enfeeblement of the patient from more prolonged abstinence might be met by the use of nutritive enemata, which are well adapted to the introduction into the body of stimulants, as wine if it be required by the state of weakness for the time being.

While in the diseases just mentioned a speedy return to the normal condition is favoured by the most entire sparing of the digestive organs, even at the cost of a considerable loss to the body, in cancer of the stomach the diet must be so arranged that on the one hand the emaciation shall not proceed too rapidly and that on the other the pain of eating shall be reduced as much as possible. It is not always possible to reconcile these aims, and one finds oneself occasionally compelled to temporarily restrict the diet to an extreme degree, or even to withhold food altogether when everything the patient takes causes pain and vomiting.[1]

In the more moderate degrees of dyspepia one must endeavour to administer to the patient, in spite of and without aggravating the symptoms, an amount of nourishment sufficient

[1] Severe hæmorrhages are an indication for entire withholding of food for some time; if, however, as is very frequently the case, slight admixtures of blood appear in the vomit one need not limit the quantity of nourishment, but only take more care to avoid all sources of irritation.

at least for maintaining the equilibrium of the body, for which in persons already much reduced a very small quantity is often effective.

The question as to what foods and what modes of cooking are to be recommended as best tolerated in carcinoma of the stomach admits of a general answer, that animal highly albuminous foods, as milk, eggs, and tender meat, are decidedly preferable to those which, from the large amount of hydrocarbons they contain, are easily prone to abnormal and acid fermentation. Ingesta which from their chemical or mechanical character are likely to act as irritants on the mucous membrane are to be avoided under any circumstances. For the rest one must not be too rigorous in ordering the diet of such patients, and may consult to some extent their wishes and preferences, unless they crave for things which would be clearly hurtful. It is important that they should never take more than a small quantity of food or drink at a time. As a beverage light red wine is most to be recommended, but beer and stronger alcoholic liquors are as a rule ill borne.

Many patients with carcinoma of the stomach enjoy a tolerable degree of comfort so long as they are restricted to fluid nourishment, although they suffer from advanced gastric lesions. For these milk is especially to be recommended, and in the opinion of Oppolzer sour milk is to be preferred to sweet, as less prone to form hard curds in the stomach. In other cases the limitation of the fluids and the prescription of a dry diet is found to contribute to the comfort of the patient, since in such a regimen there is less opportunity for the formation of acid and the frequent vomiting. One may also bear in mind the suggestion of Oppolzer, viz. that patients are less apt to vomit when they take only cold foods.[1]

What dietaries will give the best results with patients of this class depends on the nature and degree of the anatomical lesions and on the functional disorders depending thereon. The position and extent of the new formation, the more or less intimate alteration of the mucous membrane, and the constriction, dilatation, or change of position of the stomach itself are among the lesions which chiefly

[1] Oppolzer, 'Carcinoma Ventriculi: klin. Vortrag,' *Wiener med. Wochenschrift*, 1865, pp. 5 et seq.

determine the character of the disorders. The more accurately one can recognise the changes present the better can one lay down a regimen, instead of having to learn by degrees under what circumstances the patient enjoys the most ease. At the same time individual peculiarities are not to be neglected.

Those cases in which stenosis of the cardia exist demand a separate notice. These patients must not take any solid food, since such would be liable to stop short above the stricture, and lead to dilatation of the œsophagus and other consequences. In extreme constriction it is best to introduce the necessary food into the stomach by the pump. If, however, it be not possible thus to overcome the obstruction nothing remains but to have recourse to artificial feeding per rectum.

In regulating the diet of patients with dilatation of the stomach one must bear in mind above all things that nothing so tends to aggravate the mischief as over-repletion of this organ. The food in such cases should be of the least possible bulk and distributed over numerous meals, and the supply of fluids as far as possible restricted. The advantages presented by a dry diet in the treatment of gastroectasis were, so far as I know, first urged by Bartels, and certainly are deserving of consideration.[1] One may venture to assert that most persons are in the habit of taking more fluid than is really necessary, but even the necessary quantity may by practice be gradually reduced without the patient's comfort suffering by the change.

Since in dilatation of the stomach the food must be of the smallest possible volume it must also be mainly animal, the more so as in these very cases any large quantity of carbohydrates produces the most injurious results. In consequence of the slow and imperfect expulsion of its contents abnormal fermentations occur with great frequency in the dilated stomach, as is shown, among other evidences, by the copious vomiting of matters in a state of active fermentation. It is well known that even in healthy stomachs certain vegetable substances are prone to evolve large volumes of gases, and such foods are the more to be avoided since they are the least amenable to the

[1] *Bericht der Naturforscherversammlung zu Frankfurt a. M.* See also Jürgensen, 'Das Schroth'sche Heilverfahren,' *Deutsch. Arch. f. klin. Med.*, vol. i. p. 198.

action of the digestive juices and leave behind large quantities of indigestible residue.

In accordance with what has been said animal foods suitably prepared are decidedly the best tolerated by patients suffering from gastroectasis; but one must not forget that the demand of the organism for non-nitrogenous foodstuffs has to be provided for, and that man cannot long dispense with a certain addition of vegetable food. On this ground one cannot wholly exclude the use of a certain quantity of stale white bread and of tender vegetables, as well as of farinaceous foods, which are especially suitable on account of their mechanical character. This is in the highest degree advisable until the severity of the symptoms has abated and a presumably more stationary condition has set in, when a further deterioration of the general nutrition is less likely to occur.

The use of milk, which furnishes a most digestible form of nourishment in many diseases of the stomach, leads as a rule to no particularly favourable results in dilatation. Only in severe cases, especially those accompanied by obstinate vomiting, may the administration of small doses of milk at short intervals give good results. For such cases the iced milk treatment proposed by Pétrequin may be recommended; in this the patients are mainly fed on milk, crushed ice being given with each mouthful.[1]

As in diseases of the stomach so in those of the intestine the choice of the diet constitutes an essential part of the treatment. Quite irrespective of the nature and situation of the anatomical changes in the several sections of bowel we have the general rule that all ingesta which may lead to mechanical or chemical irritation of the mucous membrane, or leave behind large quantities of undigested residue, exert injurious effects in most diseases of the intestinal canal. This general rule admits of an exception only in the so-called habitual sluggishness of the bowel, which is not to be looked on as an attendant symptom of any particular disease of the intestinal tract, but either as presenting a remote effect of some bygone affection of the bowel or as having been gradually induced under the influence of temporary causes.

[1] See Bamberger, 'Krankh. d. chylopoëtischen Systems,' *Handb. d. spec. Pathol. u. Therapie*, vol. vi. 1855.

Of the various diseases of the organs of digestion which may give rise to habitual constipation we need here mention only chronic catarrh of the intestine, since it not seldom leaves behind for a longer or shorter time a condition of atony after the disappearance of all other symptoms.

Habitual constipation frequently arises from prolonged over-stimulation of the sensory nerves of the intestinal mucous membrane, gradually inducing a dulness of the irritability. In this way we explain the constipation that follows the continued employment of aperients, and an habitual use of coarse vegetable food acts in the same way. The irritability of the nerves of the mucous membrane and the activity of the peristaltic movements may also be gradually reduced when irritants of less intensity act through a long period, or when there is an absence of that variety in the diet which is indisputably of importance not only for the digestion but also for the maintenance of the peristaltic movements. Again, the want of those agencies which indirectly favour peristalsis may lead to constipation, and in this respect we must mention insufficient bodily exercise, on which account we very frequently meet with this condition and all its consequences in persons whose occupation necessitates a constant sitting posture.[1]

In combating habitual constipation a judicious regulation of the diet counts for much, especially in those cases which owe their origin to faulty habits. Obviously the first step must be the correction of such errors, since we know that a number of articles of food or relish are capable of acting energetically on the movements of the intestine. Yet there are many individual peculiarities in this respect, some foods, for example, causing diarrhœa in certain persons though having no appreciable action on the bowels of others.

Among the best known dietetic means of favouring the passage of the stools are honey and many kinds of fruit, especially acid ones. With some persons milk, and still more so sour milk, excites active peristalsis or even diarrhœa, though as a rule a diet of which milk forms a large part, when continued, tends rather to cause constipation.

[1] For a thorough treatment of the subject of habitual constipation see Leichtenstern, 'Verengerungen, Verschliessungen und Lageveränderungen des Darmes,' V. Ziemssen's *Handb.*, vol. vii. part ii. p. 495. Spring water drunk in large quantity in the early morning when fasting, especially when coffee is taken soon after for breakfast, will with many persons act efficiently as an exciter of peristalsis.

Among the various drinks cider deserves mention as inducing in most persons a gentle aperient action.

If habitual sluggishness of the bowels have been due to sameness of diet and a want of the necessary stimuli to the mucous membranes of the digestive organs, a change in the person's habits will, as already said, be frequently sufficient for the cure of the anomalous state. In such cases the employment of foods which exert a powerful mechanical irritation on the intestinal mucous membrane is most useful, and of these bran-bread is best known as an efficient aperient.

But even when constipation depends on some altogether different causes, and is a symptom of definite disease of the bowel, dietetic treatment is not seldom an aid to the removal of the abnormal condition. Nevertheless the means used under these circumstances must not be such as excite peristalsis by setting up active putrefaction and fermentation processes. It has long been verified by daily experience that certain foods and preparations do not agree one with another—that is to say, that when taken together or in close succession they frequently set up disorders, especially abdominal pains and diarrhœa. In this respect too there are idiosyncrasies, and there are persons who can swallow, one after another, the most opposite foods, as sweets and acids, fruits and beer, &c., without the least inconvenience, whereas with others, the taking of things which do not agree well sets up frequent abdominal pain and even diarrhœa.

In diseases of the digestive organs accompanied by diarrhœa those foods which contain a large amount of vegetable mucus, and gum are of real benefit. The reason of this is to be sought in the fact that such 'slimy' preparations invest the other ingesta and thus lessen the irritation they would otherwise exert on the mucous membrane.[1] On the other hand all ingesta which can mechanically or chemically irritate the mucous membrane of the bowel, and such as are easily prone to set up abnormal fermentative processes, or which are but imperfectly elaborated by the human digestive organs, and thus lead to

[1] The explanation of the beneficial influence of the astringent red wines in diarrhœa is not so clear perhaps. It consists, on the one side, in a depression of the reflex irritability of the visceral nerves, and on the other in checking putrefaction and fermentation processes. Cf. Leichtenstern, 'Darmverschliessungen,' in V. Ziemssen's *Handb. d. spec. Pathol. u. Therapie*, vol. vii. part ii. p. 499.

copious formation of fæces, are hurtful in diarrhœa. To these belong above all black bread, the various shell fruits, potatoes, unless they are finely divided, most green vegetables, fruits, especially in the raw state, tough meat, and all fatty or acid dishes. For the rest, the causes on the one hand which condition the production of diarrhœa, as well as the anatomical lesions of the digestive organs, and on the other the duration of the diarrhœa and the state of nutrition of the patient, must determine whether a rigidly spare regimen is necessary or whether the avoidance of hurtful ingesta, without any further restriction of the diet, will suffice for the attainment of the end we have in view.

Since any impediment to the flow of the pancreatic juice, and in even a higher degree to that of the bile, interferes with the absorption of fat, it stands to reason that in such diseases the supply of fat should be reduced as far as possible, the more so since unabsorbed fats are liable to undergo decomposition and to set up further disturbances. The deficiency of fats in the diet must be made up by an additional supply of carbohydrates if the body is not to suffer that loss which in chronic cases must always be looked for. In those cases in which the arrest of the bile depends on a gastroduodenal catarrh, not only must the supply of fats be as far as possible reduced, but the primary affection demands still more urgently a more or less restricted diet, and that in proportion to the intensity of the gastric symptoms.

It has long been known that in those diseases of the liver in which no impediment exists to the flow of bile into the intestine, degeneration and atrophy of the secreting parenchyma of the liver are certainly not without their influence on the production of bile, but probably the deficiency of the secretion from this cause is rarely very great or of much importance to digestion. Such processes, however, lead, as a rule, to a striking failure of the general nutrition, which is doubtless to be attributed chiefly to derangements in the digestion and absorption of the foodstuffs. But the impaired digestion in chronic diseases of the liver in which the passage of the bile into the duodenum is not impeded depends in part on an obstruction to the blood current in the portal vein and on the resulting stasis in the

vessels of the digestive canal, which is especially prone to occur in cirrhosis of the liver and in syphilitic hepatitis; in other cases, as in carcinoma of the liver, a sufficient explanation of the disturbed activity of digestion is not at present forthcoming.

In diseases of the liver which affect injuriously the portal circulation, and thus set up disturbances in the vessels of the stomach and bowel, the conditions for the absorption of nutriment are the more unfavourable as the blood stases exert a disturbing influence on the course of the peristaltic movements. Thus it happens that in the majority of such patients the appetite is more or less lost and that several symptoms of impaired digestion are usually present, so that one may well infer an insufficient secretion of the digestive juices. Under such circumstances the problem of averting as long as possible a progressive loss of flesh is one beset with great difficulty, and one for the solution of which the most careful selection of those foods and modes of preparation which are known by experience to be best suited for patients with enfeebled digestion fails in the end. Definite rules for the choice of foods can scarcely be laid down; one can only insist on the avoidance of fatty foods, since the absorption of any large amount of fat imperatively demands a normal activity of the intestinal functions. Perhaps, too, it would be expedient that substances which tend to excite peristalsis and frequent evacuations should enter regularly into the diet of these patients.

Since digestion always involves an increased flow of blood to the liver it is conceivable that an excessive supply of food may induce an habitual hyperæmia of that organ, especially if there be superadded the consequences of a sedentary and inactive life. In like manner the misuse of certain stimulants, &c., alcoholic drinks, and pungent condiments will doubtless act. In all cases in which hyperæmia of the liver can be attributed to dietetic excesses and injurious habits the avoidance of these must be enforced. Such persons as a rule exhibit an excessive obesity and deposition of fat throughout their bodies, which greatly favours the development of hyperæmia of the liver; their meals must therefore be so regulated as not in the long run to overtax their digestive powers, and that the excess of fat may be gradually removed. A diet as simple as possible,

which shall contain exactly the necessary amount of nutriment, especially in the form of lean meat, green vegetables, and not too large a quantity of white bread, together with the regular employment of fruit, would be appropriate, while milk and farinaceous foods, as tending to the formation of fat, would appear to be less so.[1]

Besides chronic hyperæmia still other pathological changes may be produced by dietetic errors, as cirrhosis by abuse of alcohol, and fatty liver by a mode of living leading to an abnormal deposition of fat in the body. So, too, the formation of gall-stones may often be referred to a faulty diet, for an excessive consumption of meat or free indulgence in fat and in spirits would probably favour their formation. But these suppositions want direct confirmation, though it cannot be disputed that the quantity and composition of the food must influence the formation of gall-stones. In Frerichs's opinion, however, more importance is to be attributed to too long intervals between the meals, during which the bile accumulates in the gall-bladder, and to insufficient bodily exercise.[2]

Artificial Feeding.

C. O. Steinhäuser: 'Experim. Nonnulla de Sensibil. et Functionibus Intest. Crass.' Diss. Leipzig, 1841.—C. Voit and J. Bauer: 'Ueber die Aufsaugung im Dick- u. Dünndarm,' *Zeitschr. f. Biol.*, vol. v.—H. Eichhorst: 'Ueber Resorption der Albuminate im Dickdarm,' *Pflüger's Arch.*, year 4, 1871.—W. O. Leube: 'Ueber d. Ernährung der Kranken v. Mastdarm aus,' *Deutsch. Arch. f. klin. Med.*, vol. x. 1872.—O. Czerny and J. Latschenberger: 'Phys. Untersuchungen über die Verdauung u. Resorption im Dickdarm d. Menschen,' *Virch. Arch.*, vol. lix. p. 661.—Fiechter: 'Anwendung u. Erfolge der Fleisch-Pankreasklystiere,' *Corresp.-Blatt f. Schweizer Aerzte*, Nos. 15 and 16, 1875.—G. Kauffmann: 'Zur Ernährung der Kranken vom Mastdarm aus,' *Deutsch. Zeitschr. f. pract. Med.*, Nos. 44 and 48, 1877.—A. H. Smith: 'Provisional Report on the Use of Defibrinated Blood for Rectal Alimentation,' *New York Med. Journal*, July 1878; 'Report on Defibrinated Blood for Rectal Alimentation,' ibid. April 1879. —Frey: 'Ein Apparat zur künstlich. Ernährung,' *Berl. klin. Wochenschr.*, 1879.—Chevalier: 'Contribution à l'Étude de l'Aliment. par le Rectum.' Thèse. Paris, 1879.—Catillon: 'Expériences de Nutrition par le Gros

[1] See Thierfelder, 'Hyperämie d. Leber,' in V. Ziemssen's *Handb. d. spec. Pathol. u. Therapie*, vol. viii. part i. p. 54.

[2] Cf. Schüppel, 'Krankheiten der Gallenwege,' in V. Ziemssen's *Handb. d. spec. Pathol. u. Therapie*, vol. viii. part i. p. 207.

Intestin,' *Journ. de Thérap.*, Jan. 25, 1880.—Michelacci: 'I Clisteri Nutr. e l'Alimentazione per il Retto,' *Lo Sperimentale*, June 1880.—W. Potter: 'Remarks on Rectal Feeding in Disease,' *New York Medical Record*, April 10, 1880.—Dujardin-Beaumetz: 'De l'Aliment. par le Rectum,' *Bull. Gén. de Thérap.*, Jan. 15, 1880.

Menzel and Perco: 'Ueber die Resorption von Nahrungsmitteln vom Unterhautzellgewebe aus,' *Wien. med. Woch.*, No. 31, 1869.—Krueg: 'Künstl. Ernährung durch subcut. Inject.,' ibid. No. 34, 1875.—Pick: 'Ueber Ernährung mittelst subcutaner Inject.,' *Deutsch. med. Woch.*, No. 3, 1879.

Howe: 'Transfusion of Milk versus Transfusion of Blood,' *New York Med. Record*, Dec. 14, 1878, and Jan. 4, 1879.—J. H. Brinton: 'The Transfusion of Blood and Intravenous Injection of Milk,' ibid. Nov. 2, 1878.—T. G. Thomas: 'The Intravenous Injection of Milk as a Substitute for the Transfusion of Blood.' New York, 1878.—Béchamp and Baltus: 'Recherch. Expérim. sur la Valeur Thérap. des Inject. Intraveineuses de Lait,' *Compt. Rend.*, vol. lxxxviii. No. 25, p. 1327.—Laborde: 'Des Injections de Lait dans les Veines,' *Gaz. Méd. de Paris*, No. 8, Feb. 22, 1879.—Moutard-Martin and Richet: 'Inject. Intraveineuses de Lait et de Sucre,' ibid. 46, 47, 49, 1879.—A. Meldon: 'Intravenous Injection of Milk,' *Medical Press and Circular*, p. 345, Oct. 22, 1879.—Culier: 'Essai Expérimental sur les Injections Intravein. de Lait.' Thèse de Paris, 1879.

In cases where it is impossible to administer sufficient nourishment by the natural ways attempts have been made since the time of Celsus to maintain life by means of nutrient enemata, and with this end in view milk, eggs, beef tea, &c., have been injected into the rectum. Opinions as to the worth and the success attending the use of nutrient enemata have been very various, and no wonder, when one reflects that foods of the most different nutritive values have been employed, some of them quite unsuited for absorption by the rectal mucous membrane. In favour of nutrient enemata it is especially urged that a prolongation of life has been attained by their means in a number of cases in which the ingestion of food *per vias naturales* was either entirely precluded or extremely limited. It is, however, clear that the duration of life in such cases is dependent on too many factors to enable one to determine how far an absorption of nutriment by the rectal mucous membrane has taken place, especially where any amount of food has been taken in the ordinary way. The value of nutrient enemata can only be correctly estimated when it has been ascertained to what extent the several foodstuffs are capable of being absorbed

by the rectal mucous membrane, whether they pass as such into the nutrient currents, or whether digestive processes still proceed in this part of the bowel, furnishing products that are easily absorbed.

Several early observers were inclined to the belief that the digestion of albumen was continued in the lowest tract of the intestine, although it could not be proved by exact investigation, and experiments with the secretion of the intestinal mucous membrane gave almost invariably negative results. Czerny and Latschenberger too found, in a patient with an intestinal fistula at the sigmoid flexure, that the human rectum exerted no digestive action either on coagulated or soluble albumen or on fat. Marckwald indeed observed, in one patient with a large artificial anus at the opening of the cæcum into the ascending colon, that, after the introduction of fibrin and albumen into the lower section of the bowel, peptone, tyrosin, and indol were formed, and that the matters introduced had gained considerably in weight; but well-marked signs of putrescence showed that it was a case not of the digestion but of the putrefaction of albumen.[1]

That dissolved matters can be actually absorbed by the rectal mucous membrane has long since been established, and can any moment be demonstrated by the injection of drugs possessing characteristic and easily recognised properties. But since it was formerly pretty generally held that ordinary albumen coagulable at the boiling point could not be absorbed at any point of the rectum, and that, further, all the albumen of the food must be transformed into peptone, one could not but doubt the nutrient value of enemata of ordinary liquid albumens, and recommend the injection of the complete peptones, a digestion of albumen in the lowest segment of the large intestine being deemed in the highest degree improbable. The notion that only peptonised albumens were capable of being absorbed was, however, as has been already stated, contested by Brücke on several grounds. In experiments instituted by Voit and me on the absorption of the foodstuffs in the rectum it appeared that the albuminates present in expressed meat-

[1] M. Marckwald, 'Ueber Verdauung und Resorption im Dickdarm des Menschen,' *Virch. Arch.*, vol. lxiv. p. 505.

juice were absorbed to nearly the same extent as complete peptones, whereas ordinary egg albumen was not absorbed unless some chloride of sodium were added to it.

Voit and I having kept a dog fasting for some time, until the daily excretion of urea had become nearly constant, injected several albuminates into the rectum. An absorption of albumen was shown by an increase of the urea on the days in question. After an injection of 381 grammes of the whites and yolks of eggs, which had been beaten together, no increase in the daily excretion of urea was noticed, whereas after 396 grammes of egg to which 10 grammes of salt had been added were injected the urea rose from 12·7 to 18·9 grammes, representing the metabolism of 19 grammes of dry albumen. When more salt was added to the injection considerably less albumen was absorbed and profuse and frequent diarrhœa followed. After the injection of 630 cubic centimetres of meat-juice with 38·5 grammes of albumen the excretion of urea rose from 11·5 grammes to 19·2 grammes, showing that nearly 70 per cent. of the albumen had been absorbed. When smaller quantities of meat-juice were employed, such that in the course of two days 21 grammes of albumen had been introduced into the rectum, the absorption of the albuminates injected was somewhat more complete. The last form of albumen on the absorption of which experiments were conducted was a solution of peptone. Of this 175 cubic centimetres, containing 39·7 grammes of dry substance, were injected into the rectum, when an increase of urea to the extent of 8 grammes, corresponding to 24 grammes of dry albumen, was observed.

The question whether fats are also absorbed by the rectum Voit and I were unable to decide with certainty; we indeed found in several experiments that the greater part only of the fat was discharged with the fæces, but we thought it probable that the loss was due to errors in the experiment. On the other hand we were able to establish the fact that starch was converted into sugar in the rectum and was absorbed in no inconsiderable quantity.

The experiments of Voit and myself were chiefly undertaken with the object of obtaining further data towards the solution of the question whether all albuminates must undergo conversion into peptones before absorption, or whether ordinary albumen may pass as such into the circulation. As regards artificial feeding we came to the conclusion from our experiments that

it was impossible to support man or beast entirely by the rectum, and that only a fourth part of the necessary albuminates to which carbohydrates had been added was capable of being absorbed. Of the albuminates with which we experimented only those of expressed meat-juice and the peptones seemed available for use in nutrient enemata, while white of egg with salt was found from its irritating character to be quite unsuited for this purpose.[1]

The conclusions to which Voit and I came were confirmed by Eichhorst, who also proved that the albuminates of milk, as well as solutions of myosin and alkali albumen, were absorbed in the rectum, whereas after injection of the so-called neutralisation precipitates in feebly acid solutions of syntonin, blood serum, &c., no increase in the secretion of urea could be detected.[2]

In harmony with these results of experiments on animals are the observations of Czerny and Latschenberger on a patient with an artificial anus, proving that dissolved albumen is absorbed as such by the human large intestine, and the more so the longer it remains in the bowel. The absorption was hindered by the irritable state of the intestine, induced by small injections of salt.[3] Fat in emulsion and starch paste were

[1] The peptones too, according to our experience, irritated the rectal mucous membrane, causing frequent evacuations if employed in too concentrated a form.

[2] Eichhorst, after the injection of milk into the rectum of the animals experimented on, found sugar in the urine ; he also frequently found albuminuria after the use of enemata with white of egg. It would be important to test these experiments, and in case of their being verified to seek the causes of such remarkable phenomena.

[The action of the liver cells seems necessary for the conversion of egg and albumens into serum albumen ; for the former, if injected into any of the systemic veins, are excreted unchanged by the kidney, whereas when injected into the portal vein no albuminuria follows. The superior hæmorrhoidal veins lead to the portal, but the inferior do not, and albumen absorbed by the latter would remain incapable of assimilation or metabolism. This consideration is enough to show the error of adding, as some have done, egg albumen to the saline solutions for intravenous injections in cholera, when it must act as a foreign body in the blood which the kidneys in that case have not even the power to eliminate, all secretion and excretion being suspended.—TRANSLATOR.]

[3] By way of an albuminous solution they used white of egg stirred up with $1\frac{1}{2}$ vol. of water, and, after frequent stirring and standing some time, passed through a filter. In one experiment, in which the white of egg beaten to a froth was substituted, at the end of $10\frac{1}{2}$ hours only 4·3 per cent. was found to have been absorbed. The albumen as present in the white of egg is in a form

absorbed, but in the case of the latter it is doubtful whether it was first transformed into sugar or was absorbed as starch.

By these experiments it was proved that a certain quantity of nutritious matters can be absorbed by the mucous membrane of the rectum, but no information was gained as to the particular method of artificial feeding to be recommended. Leube has since occupied himself with the problem of discovering practical rules for the use of nutrient enemata. He very rightly insists that if these are used for any length of time, and are to fulfil their proper purpose, such materials only should be used as shall not in the least irritate the mucous membrane and may be prepared without any special difficulty. Neither of these conditions being fulfilled by the perfect peptones or the expressed juice of meat, Leube brought into use the so-called enemata of meat and pancreas, in which finely minced meat with comminuted pancreatic gland or a glycerin extract of the same serves as the material for injection.

Leube gives the following directions for preparing the matter for injection :—The meat is first sliced very thin and the slices chopped as small as possible. For each injection 150 to 300 grammes of this chopped mass are taken together with 50 to 100 grammes of pancreas, freed from fats and also finely divided. The mixture is then stirred to a paste in a basin with a pestle or large spoon, a little lukewarm water (150 centimetres) having been added. The addition of the water is necessary to enable the mass to pass through the enema tube; and it must be warmed, because cold water would excite the rectum too much and lead to an instant expulsion of its contents.

If the absorption of fat as well as of albumen be desired, 25 to 50 grammes of fat may be added to the injection mass, and mixed as intimately as possible, with the help of a warmed pestle; the addition of larger quantities of fat is not advisable, since as a rule a premature evacuation of the injection would be induced thereby.

For the operation itself a common enema syringe will answer very well if a pretty wide nozzle be attached, or one may make use of the syringe specially constructed for the purpose after Leube's directions.[1] These injections of meat and pancreas have, according to Leube, the special advantage of causing no irritation to the mucous membrane of the rectum, and may consequently be retained for twelve,

very unfavourable to absorption, and even when beaten to a froth the dissepiments in which it is contained do not appear to be broken up.

[1] See the original essay, *Deutsch. Arch. f. klin. Med.*, vol. x. p. 13.

twenty-four, or even thirty-six hours. It often happens that the residue of a previous nutrient enema will have to be removed by a simple injection of water before another can be administered. If the injected matters have been retained long enough in the bowel the evacuations do not differ essentially as regards odour, colour, and consistence from ordinary fæces, affording evidence of a thorough digestion.

By experiments on animals and observations on man Leube has established the fact that the injection of flesh and pancreas is followed by the absorption of albumen and a corresponding increase of albuminous metabolism—i.e. of urea excretion. It further appeared, from an examination of the evacuations after the use of these enemata, that, apart from the manifest digestive changes which the injection had undergone when retained for some time in the bowel, a part of the injected albumen had disappeared by absorption. Small quantities of fat, too, which had been mixed with the meat and pancreas paste could only be recovered to a small extent. The addition of starch to the enemata led as a rule to a too hasty expulsion of the whole mass; in explanation of which Leube suggests that the conversion of starch into sugar by the pancreatic ferment takes place so rapidly that the large quantity of the resulting sugar in the rectum stimulates it to evacuation of its contents. The patients on whom Leube made his observations frequently stated that some time after the injection the sense of hunger previously felt disappeared, and was succeeded by a feeling of satisfaction.

It admits of no doubt that by the help of pancreatic meat enemata a certain amount of nutriment may be introduced into the system, and they present the advantage over other materials that have been recommended for injection of not irritating the rectum and of being prepared without difficulty. If, however, any should entertain the idea that it is possible by their means to support the organism entirely we must demur, and insist on the fact that by the help of nutrient enemata it is impossible to effect the absorption of more than a fourth part of the nourishment necessary for subsistence. One must bear in mind that the capacity of the rectum is limited and that the digestion of the injected matters demands a considerable time, so that the results will not be improved by repeating the injections at shorter intervals, for the digestion of each will

only be the less perfect. If we assume that the patient receive daily by the enemata 200 grammes of meat, 80 grammes of pancreas, and 50 grammes of fat, and retain it a sufficient time for digestion, it is clear that this amount is not adequate to the maintenance even of a feeble subject, although the greatest part should be actually absorbed. In particular cases one may succeed in introducing a somewhat larger quantity of meat (up to 300 grammes) into the rectum, but the demands of the organism for non-nitrogenous matters still remain unsatisfied.

The idea that by means of pancreatic meat enemata the total requirements of the organism can be met certainly receives no sufficient corroboration from Leube's observations; he has only shown that in this way a certain amount of nourishment, i.e. of albumen, can be absorbed, a result to be by no means undervalued.

In an animal which had been fed exclusively on non-nitrogenous substances the daily excretion of nitrogen rose, after injections of 60 to 80 grammes of pancreatic meat mixture, from an average of 0·73 grammes to 1·23 and 1·75. In two other experiments on a dog in a condition of nitrogenous equilibrium a quarter of the daily allowance of meat was administered per rectum, instead of per os, with the addition of about 20 grammes of pancreas, for several consecutive days. On most of those days the animal excreted not very much less nitrogen than on those on which the whole of the meat had been taken by the mouth.

A man who was maintained in nitrogenous equilibrium on a daily diet of 200 grammes of meat, 200 grammes of bread, 100 grammes of cheese, 20 grammes of butter, one litre of beer, and $\frac{1}{2}$ litre of milk, and who during four days of observation excreted an average of 41·5 grammes of urea, passed 33·7 and 39 grammes of urea on two days when his ration of 200 grammes of meat was administered, together with 80 grammes of pancreas, per rectum instead of by the mouth.

In another experiment a dog was kept for two days on a non-nitrogenous diet, and the nitrogen in the fæces was found to be during that time 9·28 per cent. The animal was then left for two days entirely without food, and after the bowel had been cleared by an enema an injection of 75 grammes of meat and pancreas, containing 3·07 grammes of nitrogen, was administered. After this had remained 21 hours in the bowel the animal was killed and the contents of the large intestine were analysed. There were found 26·5 grammes of fæces, in which 2·65 grammes of nitrogen were contained. Of these 2·65 grammes of nitrogen, Leube estimated that 2·46 should be left out of the account, on the ground that without the pancreatic injection

the dog would have excreted in that time 26·5 grammes of fæces, with 9·28 per cent., or 2·46 grammes, of nitrogen. Leube, in making this deduction, himself remarks that it might be objected to, and in fact it appears to be estimated too high if 25·5 grammes of fæces with 9·26 per cent. of nitrogen were obtained in a case of a fasting dog. One cannot therefore entirely agree with Leube when he infers from this experiment that the greater part of the injected albumen was absorbed.

So far as concerns the therapeutic employment of pancreatic meat enemata Leube has reported on three cases in which they were tried. The first patient, who suffered from cancer of the omentum, vomited almost immediately after taking food, and was reduced to a state of extreme emaciation when the nutrient enemata were begun. By their means an improvement in the general condition was effected and death presumably deferred. The injections, which were very well borne, consisted, as a rule, of 250 grammes of meat with 70 to 80 grammes of pancreas, and towards the close of life 25 grammes of fat were added thereto.

To a patient with cancer of the stomach, who suffered from extreme digestive disorder and frequent vomiting, nutrient enemata were administered for eleven consecutive days, at first of 250 grammes of meat with 80 grammes of pancreas, next 375 grammes of meat with 120 of pancreas, and lastly 300 of meat, 100 of pancreas, and 50 of fat. On several of the days during which the patient received nutrient enemata the excretion of urea was noted and found to be 18·1, 21·2, 21, and 29·4 grammes, whereas on the day after the enemata were left off 25·9 grammes were passed.

For a long time, i.e. for several weeks, these nutrient injections were employed in a case of poisoning with tincture of iodine and extensive corrosion of the stomach. For some time the administration of food in the natural way had been reduced to a minimum, and the increasing debility was aggravated by repeated hæmorrhages from the stomach. The nutrient enema were commenced about eleven weeks after the occurrence of the poisoning, and consisted, as a rule, of 125 to 150 grammes of meat with 40 to 50 of pancreas. When, in consequence of a severe hæmorrhage, a state of collapse supervened, the injections were discontinued for fourteen days, but they were resumed for a considerable period, and ultimately, after a six months' illness, recovery ensued.

It cannot be disputed that in this case the pancreatic meat enemata did good service and contributed to the successful issue; it would, however, be directly opposed to well-ascertained facts if one were to assume that 150 grammes of meat and 50 grammes of pancreas could furnish a sufficient amount of nourishment for an adult man.

It is difficult to form a judgment as to the actual results of nutrient enemata in any particular case, for on the one hand a partial deprivation of food can be borne for a long time by previously well-nourished persons and in the absence of fever, and on the other one is always pleased when the patients can also take food, however little, by the natural way so soon as it can be done without danger. Thus it rarely happens that one can exactly determine what amount of nourishment the patients take per os when they are able to swallow from time to time a little milk, eggs, &c.

Many observers have borne witness to the value of pancreatic meat enemata, without, however, having furnished any evidence in their reports of the possibility of nutrition being maintained solely by these means. Nutrient enemata can serve, in cases where the reception of food in the natural way is difficult or impossible, only for the introduction of a part at least of the nutriment necessary to subsistence. Artificial feeding per anum seems especially indicated where mechanical impediments exist to the ingestion of food in the natural way; here it provides the last resource whereby the approach of death from starvation can be to some extent postponed, but not averted so long as we have to deal with a permanent and complete impediment. In cases in which a certain amount of food can be taken naturally one must not be content with the employment of enemata alone so long as it is not absolutely necessary to rely on them. Precisely in those cases in which the ingestion of food in the natural way is not altogether impracticable, but so beset with difficulties that danger threatens from the increasing waste of the tissues, is the addition of nutriment by means of enemata of the greatest utility.

How long life can be supported under the partial starvation that the exclusive use of nutrient enemata involves obviously depends on several circumstances, foremost among which is the state of nutrition of the individual in question. At any rate there are numerous instances in which artificial feeding has been maintained for 14 days and upwards without the danger of death from inanition presenting itself. Such a period is often sufficient for the removal of certain impediments to the reception of food *per vias naturales*, and it is unquestionably desirable in severe diseases of the digestive organs, especially of

the stomach, in which every act of taking food by the mouth inflicts a certain amount of injury, to allow the upper part of the alimentary canal to rest entirely and to administer nutrient enemata only. Occasionally—as, for example, when, in a state of collapse, the introduction of stimulants by the mouth is impossible, or at least inexpedient—these may be supplied in enemata and absorbed by the mucous membrane of the rectum. The stimulant most appropriate for this purpose is unquestionably wine, which, as experience shows, exerts no irritating action on the rectal mucous membrane.

As contra-indications to the administration of nutrient enemata one must recognise irritable states of the mucous membrane of the rectum, whether existing already or only developed subsequently as the effect of frequent injections. A continued use of enemata under these circumstances would be fruitless, because the matters injected would be invariably expelled in a short time. An excessive irritability of the rectum might possibly be diminished by the addition of opium to the injections, but it is doubtful whether the absorption of nutriment would not be hindered thereby. Lastly, since in extreme degrees of weakness patients are not, as a rule, able to retain the injections long enough to derive benefit from them, their use does not seem advisable until some improvement in the general condition has been attained.

Of late several experiments have been made of the injection of blood into the rectum, but the reports of these do not allow of any opinion being formed of their practical value. So far as our present knowledge of the power of absorption possessed by the mucous membrane of the rectum goes we must entertain great doubts as to any success worth naming following the injection of blood, for the passage of the unaltered constituents of blood into the nutrient currents is improbable, and the absorption of these after a previous process of digestion, if indeed such process actually took place, would present no advantage whatever over the employment of albuminates in other forms.

Attempts have been made to effect the introduction into the system of nutritive materials by other paths of absorption, viz. by the outer skin and the subcutaneous connective tissue. From the employment of baths of nutritive solutions no one

at the present day would expect any results, but the injection of nutriment in solution into the subcutaneous connective tissues and its absorption from them into the circulation would appear at first sight more encouraging.

A. Menzel and H. Perco instituted the earliest experiments on the administration of nutriment by means of subcutaneous injections, mostly on animals, but in one case on a man who suffered from caries of the vertebræ. Oil, milk, yolk of egg, and syrup were employed in this way, and as a rule 1 to 2 Austrian drachms (=4·375 grammes) were thus given. In the course of 24 hours the injected matters were always absorbed, without any symptoms of inflammation being set up.

J. Krueg has reported several experiments with subcutaneous injections in insane patients who refused to take food. Krueg injected olive oil by means of a syringe holding 15 cc.; first one and afterwards two syringefuls were injected in from 3 to 5 places. Although the injections were continued for a long time they caused no pain, and at the point of injection there appeared at most but a slight reddening, which disappeared in a few days. The same result followed the injection of syrup, but on the other hand that of a previously well-beaten egg set up violent inflammation and suppuration.

J. Whittaker tried the injection of nourishment in a case of ulcus ventriculi. The patient in question could retain neither solid nor fluid food, and could not bear nutrient enemata. Whittaker consequently injected every two hours 4 grammes of milk alternately with fresh meat-juice; 7·5 grammes of cod-liver oil were also injected every two hours. Within four days 68 injections were performed, and the patient, who was in a wretched condition, was kept alive. The injections of cod-liver oil were well borne, but those of milk twice produced slight abscesses.

Further experiments were instituted by R. Pick, who employed for the purpose almond oil, cod-liver oil, milk, yolk of egg, and defibrinated blood, beginning as a rule with injection of 1 gramme and rising to 5 or 6. At the points of injection an inflammatory redness several times appeared.[1]

The subcutaneous injection of nutriment, especially of fluid fats, solutions of sugar, and at any rate of milk, may be tried in special cases in which the administration of food by any other means is absolutely impossible so long as danger of exhaustion

[1] Pick, *Ueber subcutane Injectionen von Blut vergl. die Dissertation von Ehrlich.* Greifswald, 1875.

is imminent; but one must remember that the quantity of nourishment that can be introduced in this way is so small that the benefit can scarcely outweigh the evils inseparable from the injections.

DIET IN ANOMALOUS STATES OF THE GENERAL NUTRITION AND TISSUE CHANGE.

Since in the living organism a mutual action and reaction and an interchange of matter are perpetually taking place between the cellular elements of the tissues on the one side and the nutrient fluids bathing them on the other, it is conceivable that every fluctuation in the mass or composition of the nutrient fluids should lead to some change in the intensity of the metabolic processes, as well as in the material constitution of the cellular tissues.

The quality of the nutrient fluids, again, depends on a number of factors, especially on the supply of food, its digestion and absorption. Disturbances in any of these functions react in the first place on the nutrient fluids and through them on the nutrition of the entire body.

Again, the nutrient currents must circulate with a determinate velocity and be conveyed in due amount to each of the various organs of the body, whence it follows that derangements in the movements of these fluids, whenever such do occur, must also induce alterations in the nutrition of the whole organism or of single organs.

Changes in the general state of nutrition, and especially loss of flesh, are common consequences of diseases of the most various kinds, whether affecting the entire organism or single organs only, and they are the necessary consequences of insufficient supply of food, defective digestion and absorption, or deranged movements of the fluids, to which, as is the case in all febrile affections, an increased waste of tissue may be added. In all such cases the altered nutrition of the entire system finds a sufficient explanation in the disorder of one or more of the organic functions, with or without the increased waste consequent on the febrile temperature, although some of these may be of a secondary character. But pathology recognises

also a number of morbid processes in which disorders of the nutrition of the entire body are among the most striking and prominent of the symptoms, without one's being able to refer them to diseases of any particular organ or to explain them in a satisfactory manner. These morbid states are comprehended under the names of 'general derangements of nutrition' or 'constitutional anomalies,' although at the same time it is not possible to draw a sharp line of demarcation between these characteristic constitutional anomalies and those disorders of the general nutrition which are induced by disease of particular organs. There are cases, for instance, in which a general impairment of nutrition, arising originally through disease of a particular organ, assumes in course of time a more independent character, or at least ceases to stand in any direct relation with the primary disease.

The performance of the nutritive processes depends, however, not only on the quality of the nutritive fluids, but also on the condition of the cellular elements at the time. Accordingly the so-called constitutional anomalies are to be referred primarily either to morbid changes in the fluids or to an abnormal condition of the cell elements of the organs. Alterations in the blood, and consequently in the nutrient fluids, have been satisfactorily demonstrated in a large proportion of these cases, whose number might be increased by further research. But there are also very strong arguments to be adduced in favour of the supposition that occasionally the functions of the cells themselves are abnormally performed. One must bear in mind that all nutritive processes in the elements of the tissues —the assumption and separation of matter, the splitting up processes and syntheses—cannot be referred to mechanical conditions in the ordinary sense of the word, but must be looked on as the effects of organisation and equally subject to special derangements with it. Yet this view does not exclude the possibility of an anomalous state of cell activity being occasionally brought about through the influence of the nervous system, though there appears no pressing necessity for the removal of such cases from the group of constitutional anomalies.

The composition of the blood must necessarily be subjected

to perpetual change, since on the one hand the absorbed nutriment mixes itself with it, and on the other plastic fluids are continually transuding from the vessels to maintain the waste and repair of the tissues and to provide the material for the several secretions.[1] If, however, within long periods of time the quantity and the composition of the blood seems under physiological conditions to remain constant in each individual, it is explicable by the relation of mutual dependence subsisting between the mass of the blood and fluids on the one hand and the collective organs of the body on the other. An increase in the mass of the blood alone is therefore scarcely conceivable, and *vice versâ* the organs would not be able to maintain their original constitution if blood of appropriate composition were no longer conveyed to them. So long, therefore, as the general state of nutrition of a healthy individual does not materially vary the blood will not undergo any appreciable change either of quantity or of composition beyond the transient daily fluctuations.

So far as the exchange of the constituents of the blood extends to the red corpuscles we have unfortunately no exact data whence to conclude whether a larger proportion of these than of the more stable cellular elements perishes and has to be replaced by new formation. These gaps in our physiological knowledge render it at present impossible to come to any decided judgment as to the mode of origin of those pathological changes in the blood which consist chiefly in a deficiency of red corpuscles—whether, that is to say, they are to be explained by an increased destruction or by a diminished reproduction and replacement of the elements in question, or by both causes at once. So, too, it cannot at present be determined whether the restoration of the blood corpuscles after hæmorrhages, &c., is actually effected through an accelerated new formation of these elements, nor in what way such increased production is excited.

It has been proved by several observers, and more especially

[1] Leichtenstern (*Untersuchungen über den Hämoglobingehalt des Blutes*, Leipzig, 1878) established the fact of fluctuations in the amount of hæmoglobin at different hours of the day, depending, as he believes, on reception of food and especially to be referred to changes in the proportion of water in the blood.

through the researches of Panum and Voit, that during starvation the volume of the blood is reduced in nearly the same proportion as the body-weight, but that the relative proportion of its several constituents is not materially changed. This statement is in no way opposed to the observed fact that under the influence of insufficient or improper food changes in the composition of the blood invariably appear, especially that the blood becomes more watery and poorer in red corpuscles.[1] It has been shown by Subbotin that the percentage of hæmoglobin sinks considerably under a diet composed exclusively of non-nitrogenous matters, while a highly albuminous diet increases it.[2] Leichtenstern noticed in himself a gradual increase of the hæmoglobin in the blood along with an increase of body weight as consequences of an increased supply of albuminous foods.

The observations we possess on the influence of nutriment on the composition of the blood and the proportion of the coloured elements justify the conclusion that in anæmic and hydræmic states the supply of food is of the utmost value in restoring the normal character of the blood. First, as regards those cases in which, after a severe illness, a more or less marked anæmia is present side by side with a considerable waste of the other constituents of the body, it would appear that the most suitable diet would be one in which albuminates should predominate at the commencement and albuminates and fats later on, since it is probable that thus the blood and the solid tissues will be equally replaced. But it is open to question whether the very same principles of nutrition are applicable to cases in which the anæmia or hydræmia exists as a more or less independent pathological process, whether the anomalous character of the blood be a consequence of direct loss by hæmorrhage or of other and indirect causes tending to anæmia. It is probable that the reproduction of the most essential components of the blood, especially of the red corpuscles, would be greatly favoured if relatively more albumen were contained in the food of such patients than is

[1] See Leichtenstern, l.c. p. 64.

[2] Subbotin, *Zeitschr. f. Biol.*, vol. vii. 1871.

proper under physiological conditions. The question whether a change of the usual relative proportions of non-nitrogenous and nitrogenous foodstuffs in favour of the latter is likely to be of benefit in particular cases of anæmia may be answered affirmatively in those cases at least in which the general nutrition of the body has not suffered to the same extent as the composition of the blood when, for example, the store of fat is not consumed or when one may safely assume that the anæmia has been developed as a consequence of fatty degeneration of the organs.

Under all circumstances one must remember that, since anæmia involves also numerous disorders of digestion, we have in the diet of such patients to consider not merely the relative quantity of albumen and non-nitrogenous foodstuffs, but even more the selection and preparation of the food. On account of the atony of the digestive organs so often met with in anæmic patients, combined with a marked loss of appetite, great stress must be laid on palatable and inviting methods of cooking and on a due variety of dishes; the use of condiments and of stimulants, especially of wine, in moderate doses seems in many circumstances expedient.

It was formerly thought that in the choice of foods for anæmic and especially chlorotic patients great importance should be attached to the presence of a large proportion of iron; but the other properties of the food—its digestibility, nutritive value, and palatableness—are without doubt more important.

Moleschott recommended a liberal addition of salt to the food of chlorotics, on the assumption that the direct and indirect reproduction of the blood, and especially of the red corpuscles, would be favoured thereby.

It is founded in the nature of things that in the treatment of the so-called general disorders of nutrition the greatest weight should be attached to appropriate dietetic measures, and the more so when the development of the diseases seems to be closely connected with a diet faulty either in respect of quantity or of quality. But the task of finding for all cases of this kind a diet which shall take an exact account of the state of the digestive organs, and be calculated to compensate for

their deviations from health by means of the material effects of the food on the organism, is a very difficult one. First, our knowledge of the origin and nature of general disorders of nutrition is still in some respects very unsatisfactory, and even in those cases where we can point to some particular lesion as the original cause the details in its mode of operation are unknown to us. Secondly, experience teaches us that certain disorders of the general nutrition may persist for longer or shorter periods after the original causes have been removed, and when a dietetic plan has moreover been decided on apparently fulfilling the requisite conditions. Whether our suppositions are in part erroneous or whether certain anomalies of the fluids and cellular elements in respect of nutrition generally are capable of being influenced only in a certain degree, and that quite gradually, the future alone can teach.

Since disorders in the general nutrition are connected one with another only to a limited extent, and for the rest present very different characters, no general principles can be obtained for diet in such diseases. We may, however, mention in addition to anæmia and hydræmia a few other forms of general disorders of nutrition, and discuss shortly what is known of the state of nutrition in each, although in so doing we are trespassing on the domain of special therapeutics.

Diet in Scurvy.—There is scarcely any form of general disorder of nutrition whose origin is, at least in the majority of cases, traceable with such certainty to defects in nutrition as is the case with scurvy. At the same time it is pretty certain that the cause of the development of scurvy is to be sought not in a simple deficiency of food, but in its quality. Some authorities ascribe to certain articles of food, especially pickled meat, a direct influence in the production of scurvy, while others see its cause in a want of certain foods, or even occasionally in a too great monotony of diet. On a closer examination of those dietaries which have given rise to by far the greater number of outbreaks of scurvy, viz. those of ships and prisons, we find them marked by one special character, the want of fresh food and particularly of fresh vegetables, with which as a rule also a great uniformity of diet goes hand in hand. That the causes just named do actually play the most important part in the etiology

of scurvy is further shown by the fact that this disease is far less often met with, and does not exhibit its former malignity, since these defects in the diets of ships and prisons have been as far as possible avoided.

Among the vegetables held in highest esteem for their antiscorbutic properties are, besides greens of all kinds, potatoes, sauerkraut, and juicy fruits, especially oranges and lemons, as well as the expressed juice of these last. An adequate provision of such vegetables, &c., on board ship will very effectively prevent the development of scurvy; on the other hand dried legumes, rice, and bread have not this property. Though the supply of fresh vegetables is occasionally, especially in expeditions to very barren regions, a matter of great difficulty, yet even in the Polar regions certain plants grow during the summer—the sorrel, dandelion, &c.—which are well adapted for use as antiscorbutics.[1]

Though the want of fresh vegetables has been so often insisted on as the predominant cause of the production of scurvy the importance of other prophylactic measures must not be lost sight of. Thus fresh meat, or the better kinds of preserved meats, should be given as often as possible instead of the old pickled pork, and among stimulants, &c., the use of Liebig's extract, tea, wine, and beer is to be recommended. It is also of the utmost importance that all foods and drinks should be in a perfectly sound condition.

Our experience of the etiology of scurvy suggests that a diet may be inadequate although it contains the requisite quantity of albumen, fat, and carbohydrates. According to the hypothesis of Garrod, which has already been referred to, the peculiar cause of the phenomena of scurvy is an insufficient supply of potash salts, and the value of fresh vegetables as prophylactics against the development of scurvy is to be sought in the large amount of these salts contained in them. Indeed it is scarcely possible to conceive of any other cause which can so satisfactorily explain the scurvy-producing effects of the dietary in ships, prisons, &c., if one once recognise the value of a certain excess of potash salts in food for the maintenance of health. We have, however, as has been already remarked, certain observations which tend to prove that the organism can preserve

[1] See Immermann, 'Allg. Ernährungsstörungen,' in V. Ziemssen's *Handbuch d. spec. Pathol. und Therap.*, vol. xiii. part ii.

its constitution unimpaired with a relatively small amount of mineral matters.

Future enquiry will probably extend our knowledge of the etiology of scurvy and at the same time decide whether the antiscorbutic virtues of certain foods and drinks, empirically established, are due to the large proportion of potash salts or to some other properties.

The removal of recognised defects in the diet constitutes not only the sovereign prophylactic measure for the prevention of scurvy, and to which the comparatively rare occurrence of the disease at the present day is to be ascribed, but the injunction of proper diet is the basis of a successful treatment of the actual disease. If before the appearance of the symptoms the patient has subsisted chiefly on pickled meat, bread, and dried peas and beans, provision must be made for the supply of a sufficient quantity of fresh vegetables as well as for the requisite variety in the food. But it must be remembered that the digestion of scorbutic patients is usually more or less impaired, and that regard must be had to this in the choice of foods, in addition to which the affection of the gums renders it imperative that those foods only should be given which make little demand on the act of mastication.

It is not difficult to present those articles of food known to possess antiscorbutic powers in soft and semisolid forms. Potatoes are especially suitable for this purpose, as are the various kinds of fruits, in place of which the expressed juices and fruit conserves may be employed. In severe cases, in which there are difficulties in the way of a liberal diet, the use of the stimulants, &c., already mentioned, especially of wine, tea, and Liebig's extract, is to be had recourse to.

Since, however, all cases of scurvy cannot be proved to have their origin in dietetic evils, and the disease may arise in other ways (see p. 36), the causal indication will not under all circumstances be met by the provision of the articles of food so often mentioned, especially fresh vegetables. Experience has shown that in such the brilliant results observed in other cases are absent, and that improvement must be sought by a removal of the actual unfavourable conditions. It follows

therefore that the effect of so-called antiscorbutic foods is not specific, and that it consists merely in their meeting particular deficiencies in the diet.[1]

In other forms of general nutritive disorder in which we find, as in scurvy, a morbid disposition to hæmorrhages, especially in Werlhof's disease [idiopathic purpura], fresh vegetable foods have no value. If the hæmorrhagic diathesis have exhibited itself in persons already anæmic or greatly reduced and enfeebled, as is not unfrequently the case after long illness, and indeed has been observed in many cases of purpura, an improvement of the general mode of living and nutrition is, as would naturally be expected, of great use in restoring the normal condition of health. One must endeavour by an appropriate diet first to bring about a restoration of the red blood corpuscles, and next of albumen and fat in the tissues generally. But it is well known that the true Werlhof's disease may occur in previously well-nourished and perfectly healthy individuals, and for these cases one would prescribe a diet such as should, by checking increased action of the heart and otherwise, tend to avert fresh hæmorrhages, based thus on symptomatic indications. Such patients should take all foods and drinks cool and never in large quantities at a time; they should abstain altogether from alcohol, and milk is to be recommended for its easy toleration in these cases.[2]

Diet in Scrofula.—The influence of diet in the development of scrofula is, in the opinion of most, beyond reach of doubt, and it may still be recognised as an auxiliary cause even if in the future positive proof should be produced that the disease itself is due to infection with a specific virus. Since a particular diet may be defective or faulty from several different points of view, it appears desirable to enquire whether we possess at present any data whereby we may bring well-ascertained errors in diet and nutrition into a causal relation with the development of scrofula, or whether every sort of dietetic error may favour the appearance of the disease simply by diminishing the power of resistance of the organism. Most authorities are of opinion that an insufficient diet, and still

[1] See Immermann, l.c. et al. [2] Idem, l.c.

more one in any way improper, may, especially in the early years of life, greatly predispose to the development of scrofula, not only in those who have an hereditary tendency thereto, but in such as certainly have not. Some physicians consider that scrofula originates from diseases of the digestive organs, since a chronic irritation of the intestinal mucous membrane would tend to inflammatory enlargement of the mesenteric glands. According to this view it is due not so much to a defective material composition of the diet as to the use of those articles of food which, either chemically or mechanically, irritate the mucous membrane, or which, from the small proportion of particular foodstuffs contained in them, necessitate a constant overloading of the stomach and bowels, itself a causal condition of the development of scrofula. In fact experience bears witness that a one-sided diet of coarse vegetable food, as potatoes and black bread, favours the development of scrofula in childhood, but whether as a consequence of the chronic irritation of the digestive organs or from the lowered resisting power of ill-nourished young persons must remain undecided. As already remarked persons who subsist on vegetable foods poor in albumen, and consequently habituate themselves to a voluminous diet with an excess of carbohydrates, present that pale, bloated, or puffy aspect characteristic of the torpid form of scrofula, which depends probably on the presence of an excess of water in the tissues, together with an increase of the fat deposited in the tissues at the expense of the albumen (see p. 160).

If this be so a rational diet in infancy and early life is to be deemed one of the most powerful prophylactic measures against the development of scrofula. But it does not fall within the plan of this book to go further into the question of infant feeding, for which the reader must be referred to special treatises.

According to Birch-Hirschfeld the practice of giving children in the first years of life the same diet as the adults of the family is not only a very frequent error, but one which greatly favours the development of scrofula, for the use of rye bread, potatoes, coffee, beer, &c., cannot but act injuriously on the infant digestion. With older children these articles of food are hurtful only when taken in exces-

sive quantity, or when they constitute the chief part of the diet. The best foods for these periods of life are, in Birch Hirschfeld's opinion, good milk in the first place, meats of proved digestibility, and well-baked bread; Hartenstein's legumens [revalenta and similar preparations?] are also recommended by him as food for children. He also insists on the importance of regulating the meals both as regards the amount of food taken at a time and the length of the intervals, since errors in this direction, viz. too heavy or too frequent meals, must alike exert an injurious influence on the digestive organs.[1]

Scrofulous patients presenting considerable differences in their 'habitus' and aspect among themselves, two forms of scrofula, the erethitic and torpid, have been distinguished. This distinction has a certain value in so far that patients with the erethitic type of the disease call for a somewhat different regimen from those who present the torpid form. The indications as regards diet must obviously be different according as one has to deal with graceful, spare individuals, or with persons who, by their puffy, bloated aspect, evince a different state of bodily nutrition. In the former class of cases the use of cod-liver oil is found to be especially serviceable, whence we may conclude that in such persons the employment of any easily absorbed fats is advantageous and exerts a wholesome influence on the general nutrition.[2]

Clearly the administration of cod-liver oil can have no other aim than the absorption by the organism of larger quantities of fat, with a view to increase the store of fat in the body; precautions must consequently be taken that the patients, during the treatment by the oil, have also an adequate amount of a mixed diet, great care being exercised in the choice of foods. The digestive organs of scrofulous persons demand the most anxious and constant oversight, and even the use of the oil itself may be hurtful if it is not tolerated by and

[1] Birch Hirschfeld, 'Scrophulose,' in V. Ziemssen's *Handb. d. spec. Pathol. und Therap.*, vol. xiii. part i. p. 346.

[2] Cod-liver oil owes its peculiarity of presenting a fat very easy of absorption to the large quantity (5 per cent. and more) of free fatty acids which, according to Buchheim's researches, it contains (cf. p. 122). See Birch Hirschfeld, op. cit p. 350.

deranges the stomach. Occasionally, and especially when an insuperable repugnance exists to cod-liver oil, the consumption of other fats, as butter, fat bacon, &c., in larger quantities may produce equally favourable results.

The constitution and habit of those scrofulous individuals who present more or less of the torpid type, or at least strike one not by their leanness, but rather by a pale aspect, flabbiness of muscle, &c., make it improbable that in such cases the 'fat cure' would offer a suitable remedy for the unhealthy state of nutrition, and experience confirms the supposition. In this class of scrofulous patients cod-liver oil is, as a rule, of no particular use; on the other hand the administration of a highly albuminous diet, of small bulk and not overtaxing the digestive organs, would meet the indications, hypothetical though they still be, of lessening the fat and water and increasing the albumen in the tissues. Perhaps milk, given in reasonable quantity and with the necessary precautions, is in a number of these cases the food best calculated to bring about the desired effects in the body and at the same time to improve the state of the digestive organs. The enjoining of a diet small in bulk but rich in albumen of itself precludes the continuance of those faulty diets in which the organism receives an insufficient supply of albumen and an excess of amylaceous matters in the form of coarse vegetable foods.

Diet in Rickets.—A faulty diet, especially in the first year of life, is considered by most authorities as one of the most important predisposing causes of rickets, since a too early weaning of the infant from the mother's breast and the substitution of artificial feeding, and on the other hand a too prolonged suckling without the addition of other food, are alike calculated to do harm; but in what direction we should look for the cause of those cases in which the disease does not show itself before the second or third year, or even later, has for the most part remained uninvestigated.[1]

On the connection between faulty nutrition and the production of rickets several theories have been put forward, of which those have

[1] See Rehn, 'Rachitis,' in Gerhardt's *Handbuch der Kinderkrankheiten*, vol. iii. part i.; also Senator, 'Rachitis,' in Ziemssen's *Handbuch der spec. Path. u. Ther.*, vol. xiii. part i.

received the most support which point to an insufficient assimilation of lime salts by the growing organism as the essential agent in the development of the disease. The question whether rachitic changes can be experimentally induced by limiting the supply of lime salts to young and growing animals has, however, been answered in different ways. Besides it is doubtful whether the changes in the bones observed after simple deprivation of lime salts are to be considered as really rachitic.

The researches of E. Voit have, however, shown that in young growing animals, with a diet ample in every other respect but poor in lime, the normal ossification of the skeleton is not effected, and all the phenomena of rickets are induced. According to Voit rickets is not set up in growing animals by the withdrawal of lime from the already and normally formed osseous tissue, but, when lime salts are absent from the food, though the growth of the organic basis of the bone continues its ossification is imperfect. Lime is conveyed from all the tissues, and from the mature bone among them, to the nutrient currents, to be deposited by them in the growing bone substance, while the older bone becomes poorer in earthy matter.[1]

The results of these experiments have been recently confirmed by A. Baginsky, who found in like manner that the changes characteristic of infantile rickets followed the deprivation of lime. A. Baginsky further found that the phenomena produced by simple withholding of lime were conspicuously intensified when lactic acid was administered at the same time, but the experiments of Heiss show that this is true only of growing animals.[2]

An impoverishment of the nutrient fluids in lime not only follows as a consequence of an insufficient supply, but occurs also when the lime supplied is imperfectly absorbed and is passed away unused with the fæces; thus it is that disorders of the digestion cannot but play an important part in the production of rickets. The question whether other causal agencies should not also be taken into account is answered by the majority of authorities in the affirmative, such as the action of lactic acid; and the experiments of Wegner, who produced rickets in young animals by the administration of phosphorus along with deprivation of lime, suggest the same. But one may infer from clinical experience that not merely an insufficient absorption of lime salts into the fluids of the body, but also disorders of the general

[1] Erwin Voit, *Ueber die Bedeutung des Kalks für die thierischen Organismen*, diss. Munich, 1880.

[2] A. Baginsky, *Praktische Beiträge zur Kinderheilkunde*, part ii. 1882, and *Virchow's Arch.*, vol. lxxxvii. 1882.

nutrition, arising from a variety of causes, external and internal, are concerned in the production of rickets. To give a more exact meaning to this last supposition one must assume that under certain circumstances the deposition of earthy matter in the newly-formed bony tissue fails to be effected, either because the solvent action of the fluids on the lime salts is abnormally energetic, in consequence of an excess of lactic, carbonic, or other acid being present, or because the bones themselves are in an abnormal state of nutrition, and therefore incapable of taking up the lime.[1]

It is but right to observe that the whole question of the possible development of rickets from a deficiency of lime in the fluids, or from impediments in the way of its deposition in the bones, has been in this place treated with the utmost brevity, and so far only as seemed absolutely necessary, since the rules of diet recommended for the prevention and cure of this disease are based more or less on our knowledge of its nature and cause.

As to the amount of lime required by the infantile organism we possess but few positive data, and these can have no general value, since a body will need more lime in proportion to the rapidity of its growth.

The quantity of lime required by a growing organism cannot be directly deduced from the rate of increase of its total weight, for the growth of the skeleton does not bear any constant ratio to that of the other organs. In order, however, to obtain a provisional measure of the storage of lime in the skeleton of the infantile organism E. Voit has given a calculation by which the growth of the skeleton, and from that the weight of lime added, may be gathered from the increase of body weight of a child within the first year of life, assuming that the skeleton forms 16·7 per cent. of the total weight of the body, which it does in the new-born infant.[2] This calculation is based on a report by Camerer, who ascertained the growth of an infant from birth to the end of its first year, and on certain days also the weight of food taken by it.[3] In this way E. Voit drew up the following table :—

[1] Cf. Senator.

[2] Vierordt, 'Physiol. des Kindesalters,' p. 69 in Gerhardt's *Handb. d. Kinderkrankheiten*, vol. vii.

[3] Camerer, *Zeitschr. f. Biol.*, vol. xiv. 1878.

	Length of each Period in Days	Amount of Food			CaO in the Food	Weight of Body		Difference in Body Weight	Growth of Skeleton	CaO in Bones
		Mother's Milk in Litres	Cow's Milk in Litres	Fresh Mixed Food in Grms		At the Beginning	At the End			
I.	163	111	—	—	88·8	3,280	6,122	2,842	474·6	54·7
II.	47	25	25	—	62·25	6,122	6,870	748	124·9	14·4
III.	35	—	47	—	77·65	6,870	6,585	715	119·4	13·8
IV.	114	—	164	35	270·60	7,585	8,965	1,380	230·5	26·6 [1]

In calculating the average daily supply of lime on the one side and the quantity added to the skeleton on the other E. Voit found for the four periods the following figures:—

	Lime Supplied	Lime taken up into the Bones
I.	0·55	0·34
II.	1·32	0·31
III.	2·21	0·30
IV.	2·37	0·23

From a calculation by J. Forster an infant four months old, weighing 5·53 kilos., took in 30 days 6043·4 grammes of condensed milk with 134·7 grammes of ash, which from the composition of cow's milk would give 31·65 grammes of lime and a daily allowance of 1 06 gramme. Another infant of seven weeks took in the day 71·5 grammes of fine wheat flour, 500 ccm. of cow's milk, and 47·5 grammes of sugar, giving a total of 0·884 gramme of lime. In all these cases the amount of lime required for the growth of the skeleton was fully covered.[2] We know, however, little as to the assimilation of lime by the digestive organs of children under different circumstances, and there may be a deficiency of lime in the organism, in consequence of imperfect assimilation, even with the ample supply that is as a rule provided by a milk diet. So much the easier may

[1] The ash of the cow's milk was calculated on a mean of 0·70 per cent., with 23·5 per cent. of lime, i.e. 0·165 per cent. of lime in the fresh milk; and that of the mother's as 0·49 per cent., with 16·4 per cent. of lime, i.e. 0·080 per cent. in the fresh milk (op. cit. p. 61).

[2] J. Forster, 'Beitr. z. Ernährungsfrage,' *Zeitschr. f. Biol.*, vol. ix., 1873, and E. Voit.

In 100 grammes of air-dried wheat flour are contained—

Best whites	0·61	0·041
"	0·59	0·040
Fine flour	0·47	0·013

Liebig's *Agriculturchem.*, 1876, quoted by Voit.

this want exist when meal so much poorer than milk in lime is substituted for it, at least partially.

In discussing the dietetics of rickets the first question that presents itself is whether the amount of lime in the food is sufficient to meet the wants of the organism, which it can scarcely fail to be except in the most improper artificial feeding with an overwhelming proportion of amylacea. More often we have to do not with a want of lime in the food, but with an insufficient assimilation of the lime provided, which seems adequately explained by the presence of diseases of the digestive organs. With the relief of gastric catarrh, which is the most frequent cause of defective nutrition, not only is the principal impediment to the absorption of lime into the fluids removed, but the formation of lactic acid is reduced to its normal and limited amount. It is therefore conceivable that a regimen calculated to relieve gastric catarrh in children, is often of itself sufficient to put a stop to a further development of rickets. More detailed discussions must be sought in special handbooks and works devoted to the diseases of children; it is enough for our present purpose to insist that the amylacea, as well on account of their tendency to fermentation as of the small proportion of lime they contain, are, in general, necessarily ill-suited for the food of rickety children.

It is only during the proper period of suckling that milk constitutes a complete and sufficient diet, and it has been already mentioned that, on the evidence of trustworthy observers, a too prolonged use of the mother's breast exclusively may favour the development of rickets. Experience has shown that in such cases one must have recourse to a more varied diet; the administration of strong soups with mucilaginous ingredients, of beef tea, eggs, and finely scraped meat, and even of small doses of wine, has been found especially serviceable. It must, however, remain undecided whether the effects of these additions to the milk diet are to be sought in their influence on the organs of digestion or in other directions.

If in rickety children we are unable to point out any positive error in the diet, or evident disease of the digestive organs, we must assume the existence of a general disorder of nutrition, arising from intrinsic causes, among which hereditary dyscrasiæ

are the first to suggest themselves. Experience shows that an improvement of the general nutrition constitutes the best foundation for a cure of this form of rickets, and one must consider in each case whether the deviation from the normal nutrition is marked by an unusual pallor, accompanied perhaps with an excessive deposition of fat in the tissues of the body generally, or whether, on the contrary, it consists in an insufficient store of fat, &c.; for on this it will depend what should be the composition of the food in order to bring about the material results contemplated in each case.

Diet in Gout.—Hitherto gout had been looked on as a disease for the development of which, next after hereditary predisposition, a luxurious mode of living, especially an excessive indulgence in animal food, as well as in highly seasoned dishes and alcoholic drinks, together with insufficient bodily exercise, was of the greatest influence. Against the correctness of this empirical doctrine it could easily be urged that many persons abandon themselves to the indulgence of the table and avoid every form of exercise without ever suffering from gout, while conversely one finds among one's gouty patients those who can in no way be accused of excessive indulgence. If, however, one were to conclude from these facts that diet plays no part in the development of gout, one must also deny in the case of many other diseases the influence of the best recognised injurious agencies, because certain individuals seem to enjoy an impunity.

So long as the metabolic processes were identified with actual combustion, and the oxygen in the body viewed as its immediate cause, uric acid was held to be a low grade of the oxidation of albuminates, and it was natural to define gout as an anomaly of metabolism, in which an abnormally large amount of uric acid was formed in the body, because the nutritive materials taken in excess could not be completely oxidised. In this way the influence of luxurious living and sedentary habits on the development of gout seemed to find the simplest explanation, although the proof that gouty subjects actually produce more uric acid than healthy persons was not forthcoming.

According to the researches of Garrod, whose statements have been confirmed by subsequent observers, the excretion of uric acid

diminishes regularly and remarkably some days before the approach of an attack of gout. During the attack too there is usually at first an abnormally small secretion of the acid, which only begins to rise towards the end of the attack. It is clear that the evidence given by Garrod, that under such circumstances there must be an excess of uric acid in the blood of sufferers from gout, does not of itself prove an increased formation of that acid; the present view of the matter is well expressed by Bartels, that it is still undecided whether we have to do with an increased production of uric acid in the body of the gouty or only with a retention of this product of metabolism.[1]

Even if one admit that the production of uric acid is abnormally increased in the gouty the origin of attacks of gout and of gouty deposits is in no way explained. Garrod therefore laid special stress on the interference with the elimination of the uric acid, and referred this to a hypothetical disturbance of the function of the kidneys. Against this last notion several observers have raised objections, and it indeed appears superfluous if, with Senator, we look for the cause of the deposition of uric acid in the bodies of the gouty in a diminished solvent power on the part of the fluids for the salts of uric acid. This explanation is in harmony with the observations of Voit and Hofmann on the formation of sediments in strongly acid urine, and also gives a clue to the comprehension of the fact that an excess of albuminous diet favours the development of gout. Senator has justly pointed out that in the metabolism of albumen phosphoric and sulphuric acid are set free in excess, sufficient to increase the acid reaction of the urine. He believes too that the disturbances of the digestion, which so frequently appear as precursors of an attack of gout, may indicate an increased formation of organic acids in the blood as well as a reduction of its alkalinity.

One may perhaps be allowed to express the opinion that an explanation of the origin of the deposits of urates does not by any means enable us to fully understand the nature of gout. But the accumulation of uric acid in the bodies of the gouty supplies, at present at any rate, the main indication for the treatment, and our theoretical knowledge on this point

[1] Senator, 'Gicht,' in V. Ziemssen's *Handbuch d. spec. Path. und Therap.*, vol. xiii. part i.; also Ebstein, 'Zur Lehre von der Gicht,' *Deutsch. Arch. f. klin. Med.*, vol. xvii. 1880.

seems to possess the widest practical bearing, while all further reaching hypotheses on the nature of gout want at present any positive basis, for the presence of oxalic acid in the blood, also demonstrated by Garrod, can scarcely be reckoned as more satisfactory.

Experience has shown that gout is in the highest degree amenable to judicious dietetic treatment, the sufferings incident to the disease and the frequency with which the attacks recur being alike influenced in most cases. This holds good not only of those who have acquired the disease in consequence of luxurious living, but also of such as labour under an hereditary predisposition. Moderation in food and drink is rightly held to be the most important rule for the gouty, and one in the neglect of which there can be no hope of ameliorating their sufferings.

In the opinion of most observers the food of the gouty should contain as little albumen as possible, in order that the fewest products of its imperfect oxidation should be retained in the system, and also little fat, since this, by fixing the oxygen, would tend to hinder the oxidation of the albuminates. We now know, however, that the production of uric acid is not owing to any diminished oxidation, that, on the contrary, it rises with increased albuminous metabolism, and also that the supply of a certain amount of fat increases the excretion of this product of metabolism. More weight ought to be attached to the liberation of large quantities of phosphoric and sulphuric acids, with a liberal supply of albuminates and fat, than to the increased secretion of uric acid, since the former, as already explained, lessen the solubility of the salts of uric acid.

It would seem as if an excess of fat in the body favoured the development of gout; at the same time we must remember that corpulent individuals are prone to perspire heavily, and thus as a rule to secrete a concentrated urine, very liable to yield deposits. From this point of view it would seem expedient not merely to restrict the fat in the food of the gouty, but far more to set limits to the accumulation of fat in their persons.

Prudent physicians not only enjoin on their arthritic patients great moderation in food and drink, but also dissuade them from methods of treatment involving too rigorous abstinence. Thus Senator rightly remarks that starvation treatment

is likely to bring on a progressive failure of strength, or even a return of the typical gout in the far more unfavourable atonic form. Sufferers from gout should during their intervals of freedom, and while their digestive organs are in a condition of normal activity, take just so much food as is necessary to maintain the organism in the condition corresponding with the work required of it (see the chapter on the 'Demands of the Organism for Nutriment'). In fact it appears thoroughly practicable to obviate the disadvantages that would accrue to the gouty from a liberal diet by taking precautions to ensure a regular and abundant provision of vegetable food. Above all it is the green vegetables and fresh fruits which, when taken in ample quantity, are capable, as is well known, of imparting an alkaline reaction to the human urine, that are especially suited to the gouty, as well as because, from the small proportion of organic foodstuffs they contain, they do not favour the deposition of fat in the body. One cannot, however, but agree with Senator when he warns us against an exclusively vegetable diet, since it is altogether ill adapted to the human digestive organs and burdens the system with an excess of carbohydrates, whereas it is precisely in gouty cases that the digestion calls for the most watchful care.

Smoked and pickled meats and fish, game, and pork are especially injurious to the gouty; also cheese, fatty dishes, and farinaceous foods prepared with much seasoning.[1] Eggs too, and foods made with them, are, according to Senator, to be avoided as much as possible, since the yolks of the eggs, from the large quantity of fat and lecithin in them, act prejudicially. He also deprecates the use of tea and coffee, recommending as a substitute either acorn coffee or an infusion of cacao nibs, or even milk. For ordinary use Senator advises water and alkaline and acidulous (tartrates of potash, &c.) beverages. Alcoholic drinks should be given only as the patient's strength requires, and for this purpose the light red wines and good light beer are the best.[2]

An essentially different regimen for gouty patients has been recommended by Cantani.

[1] In some countries the use of poultry, especially of fowls and pigeons, is considered as particularly favourable to the production of gout.

[2] Senator, op. cit. p. 166.

According to Cantani gout is to be viewed as an anomaly of metabolism characterised by imperfect transformation and combustion of the products of oxidation, of which the uric acid diathesis is merely the most conspicuous symptom. The occurrence of an accumulation of uric acid in the blood is explained by Cantani as due to a want of co-ordination between the ingested nutriment and the capability of the organism to burn off and consume the same; we have to deal with a partial arrest of the metabolic process, terminating at the stage in which the nitrogenous matters are transformed into uric acid.

As to the influence of a too highly albuminous diet on the production of gout, the ingestion of such foods may, Cantani admits, doubtless exceed the oxidising power of the organism, so that it is unable to consume them and to oxidise them into the last terms of normal metabolism. But the imperfect oxidation and the excessive production of uric acid may in many cases result, in his opinion, far less from an excessive ingestion of albuminates than from a lessened consumption of those bodies taken in moderate amount. The actual cause of the inactivity of the metabolism is in such to be sought in the individuality and temperament of the organism.

Cantani does not approve of the usual treatment of gout, which prescribes the utmost possible abstinence from meat and other highly albuminous animal foods (with the exception of milk) and considers the use of vegetables, fruit, and farinaceous foods as more suitable. It attempts to prevent the imperfect oxidation of the albuminates by means of a diet from which these are, as far as can be, excluded, whereas one ought rather to aim at effecting their complete combustion, since they can never be altogether withdrawn from the food. In Cantani's opinion the supply of those bodies which are known to save the albuminates and to check oxidation, viz. the fats and carbohydrates, should be reduced so far as possible. The use of acids, which lessen the alkalinity of the blood and fluids of the tissues and favour the formation of precipitates of water, must be prohibited.

Cantani therefore recommends those suffering from gout to take a moderate allowance of an albuminous diet, consisting of meat or fish, eggs, bouillon, and green vegetables. All starchy and saccharine foods and dishes, farinaceous foods, bread, rice, potatoes, sweets, and fruits, also alcoholic drinks, pungent seasonings, and coffee, should be avoided. All acids and acid

foods, as well as milk and cheese, are to be stoutly forbidden, since the injurious effects of lactic acid and of the fatty acids in cheese can be directly proved. Cantani orders pure or aerated waters as a beverage, and advises his patients to take a large quantity of fluids. The method of Cadet de Vaux, who in the treatment of gout ordered the drinking of large quantities of very warm water, is, however, when carried to an extreme, to be deprecated, but during the non-febrile intervals between the attacks a moderate use of water, not too warm, taken night and morning, may be of great service. The rigid regimen described above must be persevered in for several months, when the diet may be somewhat extended, though a free use of the more injurious foods is always to be shunned.[1]

The dietetic rules which in the present state of our knowledge appear appropriate for gout may be equally applied in the case of deposits of uric acid in the urinary passages; for in treating uric acid concretions in the urinary passages we have as a rule to deal with the passage of large quantities of urates into the urine, beyond its power of dissolving them. The more concentrated the urine the stronger is its acid reaction, and the more easily will precipitates of uric acid be formed. The proportion of acid phosphates of the alkalies present in the urine is also of importance here, since these salts, by forming a basic phosphate of soda, withdraw the bases of the urates and cause the precipitation of uric acid or of an acid urate of potash.[2]

In order to lessen the acid reaction of the urine the use of large quantities of vegetable foods is to be recommended so long as any tendency to the formation of uric acid deposits is observed; care should also be taken to ensure a due dilution of the urine by free potation. But most physicians consider acid foods and drinks as hurtful, since they increase the acid reaction of the urine, and Cantani holds that the assertion of many writers that organic acids increase the alkalinity of the urine and pass into it in the form of carbonates is incorrect. It is true only of small quantities, whereas their continued use in larger quantities causes the urine to become more and more acid.[3]

It has been repeatedly stated that in countries where beer is drunk concretions in the urinary passages are less frequently met with than

[1] A. Cantani, *Spec. Path. u. Ther. d. Stoffwechselkrankheiten*, vol. ii. 1880.

[2] *Zeitschr. f. analyt. Chem.*, vol. vii. p. 397.

[3] A. Cantani, op. cit. p. 207.

in wine districts, which may be connected with the fact that beer contains less alcohol and less organic acid than wine.[1] Accordingly all the stronger alcoholic drinks should be forbidden to such persons as suffer from uric acid concretions; only with regard to beer some few have ascribed to it a beneficial influence in urolithiasis.[2] Tea too aids the prevention of uric acid deposits, and Moleschott quotes the assertions of several Dutch physicians who maintain that since the introduction of tea stone has become rare.

Diet in Diabetes mellitus.—It is unanimously recognised by all observers, whichever of the numerous theories of the nature of diabetes mellitus they may hold, that the prominent symptom of this disease—namely, the elimination of sugar in the urine—is dependent to a great extent on the food.

The question whether dietetic errors may be reckoned among the etiological factors of glycosuria has been answered in the affirmative by several authorities; Cantani especially sees in the excessive use of farinaceous and saccharine foods an important cause of the development of a tendency to diabetes. He has noticed that glycosuria is a far more common disease in southern Italy than in most other countries, a fact which he believes to be connected with the excessive use of carbohydrates. Cantani suggests that the organ the regular activity of which is necessary for the transformation of sugar becomes exhausted by excessive strain, besides being insufficiently nourished by a diet poor in albuminates, so that by degrees an irregular performance of function and ultimately actual disease is induced.[3]

In the opinion of Senator the influence of an excessive use of carbohydrates can scarcely be viewed as direct, because otherwise this disease would be far more frequent in other countries where the population subsist on a diet in which vegetable foods predominate. Besides although mere transient glycosuria has been known to follow the intentional ingestion of large quantities of sugar, genuine diabetes never has. Senator therefore maintains that an improper diet may have given occasion to the development of diabetes in a certain number of cases only, in consequence of the chronic disorders of digestion caused

[1] Moleschott, op. cit. p. 568.

[2] Cf. W. Ebstein, 'Nierenkrankheiten,' in V. Ziemssen's *Handb. d. spec. Pathol. u. Therap.*, vol. ix. part ii. See there also on the origin and treatment of those concretions which are not formed of uric acid or of urates.

[3] A. Cantani, *Spec. Path. u. Ther. d. Stoffwechselkrankheiten*, translated by S. Hahn, vol. i. p. 289. Berlin, 1880.

thereby, but which in his opinion doubtless stand to it in the relation of cause to effect.[1]

In diabetes mellitus the sugar introduced with the food or formed within the organism is only imperfectly applied in the animal economy, since a greater or less proportion of it is washed out of the body with the urine, without having undergone the normal splitting up. The sugar and the sugar-forming substances must therefore present in the body of the diabetic the character of useless ballast; besides clinical experience shows that the extent of the excretion of sugar in the urine, so far too as it is dependent on the diet, has a great influence on the general well-being of the patient. For these reasons the overwhelming majority of authorities hold that the carbohydrates, so far as they tend to increase the excretion of sugar in the urine, should be excluded from the diet of diabetics, and that the material demands of the patient must be met chiefly by the administration of albumen and fat.

The influence of the food on the quantity of sugar excreted in diabetes mellitus is established by numerous observations. At the same time it must be admitted that the results of a so-called exclusively meat diet are not always the same, since in slight cases the saccharinity of the urine speedily diminishes and in time entirely disappears, whereas in severe ones the excretion of sugar, although in lessened amount, persists in spite of the entire withholding of carbohydrates. Since this difference has been recognised some writers would assume a mild and a severe form of diabetes, not indeed two essentially different pathological processes, but two distinct stages or degrees of the same disease, as is proved by the passage occasionally observed of the one form into the other.

It was formerly thought that all kinds of sugar and starches increased the excretion of sugar in diabetics, but the observations of Külz, Frerichs, and Von Mering have shown that this does not hold good for every one of the carbohydrates.

Külz tested the influence of grape sugar, mannite, dextrin, fruit

[1] Senator, 'Diabetes mellitus,' in V. Ziemssen's *Handb. d. spec. Pathol. u. Therap.*, vol. xiii. part i.

sugar, inulin, cane sugar, milk sugar, and inosite on the excretion of sugar in diabetes, and found that neither in the mild nor in the severe cases had mannite, fruit sugar, inulin, or inosite any effect in increasing the sugar in the urine ; that, in fact, these bodies were almost entirely metabolised in the body, since they were to be detected unchanged in the excreta either in very small quantity or not at all.

Külz considers it possible that there are cases of diabetes in which a part of the fruit sugar ingested passes out unchanged with the urine, and in these inulin would probably partly appear in the urine as fruit sugar. It would be desirable to try the effects of administering each of these carbohydrates, for in those cases in which inulin is really utilised in the body it would be of great value as a substitute for bread, which as a rule is severely missed.[1]

Another carbohydrate which Külz thinks may possibly be well suited for the manufacture of diabetic bread is to be found in the 'moss starch,' so called (lichenin), which forms a principal constituent of Iceland moss. Külz could not obtain any practical experience of the use of moss starch among diabetics, but experiments in this direction are much to be desired, because, according to a statement of Moleschott's, the inhabitants of Iceland, Lapland, &c., make a very palatable bread from the meal of this lichen after having freed it from the bitter extractive matter by repeated washings.

The experiments that Külz carried out with milk sugar gave remarkably diverse results, in some a relatively considerable increase of the sugar in the urine appearing, while by other patients milk sugar was borne surprisingly well.[2]

The fact that all the carbohydrates do not increase the excretion of sugar is one of some importance in the treatment, since on this ground the use of vegetable foods, making a change in the otherwise intolerable monotony of the diabetic diet, may be justified.

Külz suggests the preparation of an inulin biscuit thus :—Fifty grammes of inulin are to be put in a large porcelain basin, and while standing over a water bath to be rubbed up with 30 ccm. of milk and as much hot water as may be necessary into a uniform dough, with which the yolks of four eggs and a little salt are to be mixed. To this the whites of the four eggs are to be added, having first been beaten to a foam, and carefully worked in. The dough is finally to be baked in tin moulds previously smeared with butter. The taste of the biscuits may be improved by the addition of vanilla or other spices.

[2] E. Külz, *Beitr. zur Pathol. u. Therap. d. Diabetes mellitus.* Marburg, 1874.

Since in the diabetic subject, in consequence of the excretion of sugar in the urine, a certain portion of the foodstuffs, which in the normal organism would have been utilised in the economy, is withdrawn unused, it is quite conceivable that persons suffering from glycosuria may require a larger amount of food to meet the needs of their system than others. In fact an exaggerated craving for food is one of the most usual symptoms of diabetes, many patients taking enormous quantities and notwithstanding all losing flesh at the same time. These long-known facts suggest the important question whether the exaggerated demand for nutriment in the diabetic is to be considered simply as a result of the imperfect elaboration of sugar in the organism, or whether the conditions under which metabolism in general is performed in the organism differ in other respects from the normal.

Under normal circumstances man is in the habit of taking large quantities of carbohydrates, which in the diabetic would be most imperfectly utilised, so that in a mixed diet a waste of materials, corresponding to the excretion of sugar, follows, which must be met by an increased supply of food if loss of flesh is to be averted. In this way it is easily explained why a diabetic cannot satisfy his wants on a mixed diet which would be ample for a powerful labourer. But even when the carbohydrates are as far as practicable excluded from the diet of the diabetic there will still, at least in severer cases, be a more or less considerable excretion of sugar, and a part of the nutriment taken in is thus lost to the organism. Again, even in health it is by no means easy to provide the necessary amount of nitrogen and carbon in the forms of albumen and fat alone, to the exclusion of carbohydrates. For example, a labourer who, to meet his daily need for carbon, takes 328 grammes of carbohydrates, would have to consume, in addition to his usual allowance of albumen, no less than 346 grammes of fat, which to most persons would certainly be impossible (see p. 159). The same would hold good of the diabetic, and consequently there is in their diet no proper relation maintained between the nitrogenous and non-nitrogenous foodstuffs, the albuminates being in far too high a proportion. From what we have said before it will be seen, too, that of such a diet a far

larger bulk is required to preserve the balance between the income and the output than is the case in one poorer in albumen but richer in carbon. These considerations are, in fact, felt by many to be sufficient to account for the craving of diabetics for more food, and they look on the enormous excretion of urine in many diabetic patients only as a necessary consequence of the excessive ingestion of albumen.

The large amount of urea and of phosphoric acid excreted by diabetics has been noticed by many observers; C. Gaethgens especially by parallel experiments conducted on a healthy and a glycosuric person ascertained that on a mixed diet the latter constantly metabolised more than the normal amount of albumen.[1] Pettenkofer and Voit also observed that a diabetic of 54 kilos. body weight when fasting metabolised in 24 hours 326 grammes of flesh and 154 grammes of fat, while a working man of 71 kilos. metabolised 328 grammes of flesh and 209 of fat, and an ill-nourished though otherwise normal man on the first day of fasting only 200 grammes of flesh. It is, however, nothing unusual for diabetics in advanced stages of the disease to excrete two or three times as much urea as healthy persons. Senator once observed five times the standard, and in a case reported by Fürbringer 163 grammes of urea were estimated in the 24 hours. All these observations indicate unmistakably that in the diabetic the conditions of the metabolism of albuminates are different from the normal, and indeed most authorities are agreed in this. Huppert, as well as Pettenkofer and Voit, suggest that in the diabetic subject changes are induced in the cellular elements in consequence of which the organic albumen is constantly passing into the circulation in abnormal quantities, and there undergoing metabolism. In Senator's opinion the hypothesis of an increased destruction of the albumen of the organism is applicable only to the severer cases, while in those who on an exclusively animal diet excrete no sugar the abnormally large elimination of urea is to be accounted for by the increased

[1] C. Gaethgens, *Ueber den Stoffwechsel eines Diabetikers verglichen mit dem eines Gesunden*, diss. Dorpat, 1866.

consumption of albuminous food and the copious diuresis. If this be so the slighter cases, who when carbohydrates are withheld excrete no sugar, ought to be able to satisfy their bodily demands with the same quantities of albumen and of fat as healthy persons under like circumstances. So far as I know no observations are recorded which support this view, and it must at present remain doubtful whether diabetes always induces an increased waste of albumen or whether this only appears in the later stages of the disease.

On the consumption of fat by diabetics we have as yet but little positive evidence, and indeed only the observations of Pettenkofer and Voit, who investigated the entire economy of a glycosuric patient under various circumstances. From the twelve experiments conducted by them, both fasting and with different diets, the following seem best calculated to give an insight into the economy of a diabetic and the effects of the several foodstuffs.

I. *Elements of the Income and Output of a Diabetic when Fasting.*

		Water	C	H	N	O	Ash
Intake.							
Meat extract .	35·9	11·4	7·0	1·4	3·4	8·8	6·9
Salt . .	22·3	0·3	—	—	—	—	22·0
Water . .	2590·0	2589·0	—	—	—	—	1·0
Oxygen of air	344·0	—	—	—	—	344·0	—
	2992·2	2690·7 = 288·9H 2311·8O	7·0	1·4	3·4	349·8 2311·8 2661·6	29·9
Output.							
Urine . .	1412·6	1310·0	32·6	4·5	14·5	39·4	11·6
Breath . .	1223·3	721·1	136·9	—	—	365·3	—
	2635·9	2031·1 = 225·7H 1805·4O	169·5	4·5 225·7 230·2	14·5	404·7 1805·4 2210·1	11·6
Difference .	+356·3	—	−162·5	+60·1	−11·1	+451·5	+18·3

The urine contained 52·10 grammes of sugar, 28·50 grammes of urea, and 11·59 grammes of ash.

II. *Elements of the Intake and Output of a Diabetic with an Abundant Mixed Diet.*

	Water	C	H	N	O	Ash
Intake.						
Meat[1] . . 530·1	313·2	112·7	15·6	30·6	46·3	11·7
Bread . . 744·7	345·2	181·4	25 8	9·5	166·3	16·4
Butter . . 265·7	18·7	195·0	27·1	0 3	14·6	—
Suet . . 107·5	—	84·9	11·8	—	10 7	—
Egg (raw) . 96·1 ,, (hard) . 58·8	125·5	15·7	2·1	4·3	6·4	0 9
Milk . . 2575·0	2242·3	181·5	28·6	16·2	87·5	18 8
Cranberries . 25·2	17·6	3·0	0·5	—	4·1	—
Salt . . 13·8	0·2	—	—	—	—	13·6
Beer . . 969 0	908 7	24·2	4·1	0·6	28·9	2·6
Water . . 6416 0	6416·0	—	—	—	—	2·6
Oxygen from air . . 792·0	—	—	—	—	792 0	—
12593·9	10348·8 =1153·8H 9231·00	798·4	115·3 1153·8 1269·1	61·5	1167·2 9231·0 10398·2	66·6
Output.						
Urine. . 11480·0	10665·4	302·0	50·9	47·0	379·0	35·7
Fæces . 951·7	768·1	88·8	13·1	10·4	40·4	30·8
Breath . 1574·9	758·8	222·5	15·3	—	578·3	—
14006·6	12192·3 =1354·7H 10837·60	613·3	79·3 1354·7 1434·0	57·4	997 7 10837·6 11835·3	66·5
Difference . −1412·7	—	+185·1	−164·9	+4·1	−1437·1	+0·1

In the urine there were contained 100·7 grammes of urea, 644·1 grammes of sugar, and 35·7 grammes of ash.

III. *Elements of the Intake and Output of a Diabetic on an Albuminous Diet without Carbohydrates.*

	Water	C	H	N	O	Ash
Intake.						
Meat[2] . . 751·4	426·0	196·0	23·3	45·9	69·6	17·5
Suet . . 80·0	—	63·2	8·8	—	8·0	—
Salt . . 13·7	0·2	—	—	—	—	13·2
Water . . 3000 0	2998·8	—	—	—	—	1·2
Oxygen of air 613·5	—	—	—	—	613·5	—
4458·6	3425·0 =380·5H 3044·50	232·2	32·1 380·5 412·6	45·9	691·0 3044·5 3735·5	32·2

[1] 530·1 grammes of cooked meat = 900 grammes of raw.
[2] 751·4 grammes of cooked meat = 1,350 grammes of raw.

		Water	C	H	N	O	Ash
Output.							
Urine .	. 2593·3	2357·7	72·0	14·0	29·1	95·0	24·5
Fæces .	. 1713·0	1627·4	37·2	5·3	5·0	17·1	21·0
Breath .	. 1294·4	658·3	171·6	6·8	—	457·7	—
	5600·7	4643·4 =515·9H 4127·5O	280·8	26·1 515·9 542·0	34·1	570·7 4127·5 4698·2	45·5
Difference	−1142·1	—	−48·6	−129·4	+11·8	−962·7	−13·3

The urine contained 62·4 grammes of urea, 148·7 grammes of sugar, and 24·5 grammes of ash.

IV. *Elements of the Intake and Output with a Non-Albuminous Diet.*

		Water	C	H	N	O	Ash
Intake.							
Starch .	. 500·0	78·9	186·0	28·2	—	206·7	—
Cane sugar .	100·0	—	42·1	6·4	—	51·5	—
Butter .	. 105·0	—	82·9	11·5	—	10·5	—
Water .	. 3344·2	3342·9	—	—	—	—	1·3
Beer .	. 1537·5	1442·0	38·3	6·5	1·0	45·8	4·1
Cranberries .	18·0	12·6	2·3	0·3	—	2·8	—
Oxygen of air	591·9	—	—	—	—	591·9	—
	6196·6	4876·4 =541·8H 4334·6O	351·6	52·9 541·8 594·7	1·0	909·2 4334·6 5243·8	5·4
Output.							
Urine .	. 4396·4	3938·2	175·4	29·8	9·05	233·9	10·0
Fæces .	. 1833·7	1655·6	78·0	12·1	4·08	68·2	15·7
Breath .	. 1392·5	761·7	173·4	7·7	—	449·7	—
	7622·6	6355·5 =706·1H 5649·4O	426·8	49·6 706·1 755·7	13·13	751·8 5649·4 6401·2	25·7
Difference	−1426·0	—	−75·2	−161·0	−12·13	−1157·4	−20·3

The urine contained 62·4 grammes of urea, 148·7 grammes of sugar, and 24·5 grammes of ash.

From the observations of Pettenkofer and Voit on the entire economy of a diabetic whose symptoms indicated the severer form of the disease we may conclude that the patient, alike

when fasting and when feeding, metabolised more albumen than a normal man would under like circumstances. Only when receiving abundance of albuminous food was there no loss of albumen from the body, far less any gain of flesh. Even the waste of carbon in the body of the diabetic was very much greater than the normal, and that in consequence of the excretion of sugar in the urine, while the elimination of carbonic acid by the skin and lungs and the absorption of oxygen from them constantly gave a lower figure than the normal. The elimination of carbon too was quite differently distributed between the several excretions from what it is in health, as will be seen by the following figures, taken by Pettenkofer and Voit, showing the number out of every 100 grammes given off which were eliminated by the kidney and by the skin and lungs respectively in two persons on a liberal mixed diet :—

	In the Diabetic	In the Healthy Man
Through the urine . . .	50	6
,, skin and lungs .	36	88

The knowledge we possess of the metabolism of diabetics, and of the influence on it of the several foodstuffs, and not any still incomplete theories as to the nature of glycosuria, must guide us in the regulation of the diet of these patients. In the forefront stands the fact that with an exclusively animal diet the excretion of sugar may, in slighter cases, be entirely suspended, and even in more advanced cases may be kept at a lower figure than it would be on a mixed diet. Every diabetic must be strenuously urged to satisfy the demands of his organism by means of a diet consisting exclusively of albuminates and fat. But such a diet involves embarrassments which compel us to grant certain concessions and make it much to be desired that we could have a somewhat greater play in the choice of foods. The severer the case the more rigid should be the regimen enjoined, whereas in slight cases a small quantity of sugar-forming substances does not seem to have any influence on the excretion.[1]

[1] That the power of applying sugar to the purposes of the animal economy is not totally lost in diabetes melli us is clear from the experiments of Külz,

The principal difficulty arises from the repugnance which sooner or later arises to an exclusively flesh diet. Besides, the amount of fat which, in the absence of carbohydrates, seems necessary to satisfy the call for carbon is in the long run barely tolerated by the digestive organs, although it must be admitted that many diabetics have the power of absorbing and utilising very large quantities. If, however, one attempt to meet the demand for carbon by albuminates alone this would necessitate in the slighter cases even a mass of albuminous foods altogether unmanageable, to say nothing of the severer cases in which even a part of the carbon contained in flesh fails to be assimilated and is passed out of the system in the form of sugar; and added to all that the metabolism of albumen is, in and by itself, probably much greater than under normal conditions. With an insufficient supply of fat the diabetic must ingest such enormous quantities of albumen that the powers of his digestive organs are unable to keep pace with the demands of the organism, which is thus driven to the consumption of its own substance.

Many years since O. Schultzen advanced the theory that in diabetes the sugar is excreted unaltered, in consequence of the absence of the ferment by which it is under normal conditions broken up into glycerin and glycerin aldehyde. Glycerin, on the other hand, is completely oxidised in the organism of the diabetic into carbonic acid and water, so that in conjunction with a flesh diet it is well fitted to reduce the excretion of sugar and at the same time to materially improve the general nutrition. But after thoroughly testing the suggestion of O. Schultzen most observers have come to the conclusion that glycerin in large quantities acts injuriously, and only in solitary instances were small doses of glycerin well borne by diabetics.[1] From the very limited admissibility of glycerin in diabetes one must obviously not draw the conclusion that the neutral fats are equally useless, since the action of these in the organism is totally different from that of

for his patients were able, even in the advanced stages of the disease, to metabolise large quantities of sugars. Another observation of Külz is especially worthy of notice, that muscular exercise greatly increased the metabolism of sugar in the organism of the diabetic, lessening the excretion to a corresponding extent.

[1] For a closer examination of this subject see Senator, op cit.: also Külz, *Deutsch. Arch. f. klin. Med.*, vol. xii. p. 248, and *Beiträge zur Pathol. und Therap. des Diabetes mellitus und insipid.*, ii. Marburg, 1875.

glycerin, and experience proves that they do not lead to any increase of the saccharine excretion.

From what has been said the diet of the diabetic must consist mainly of meat and fat; but all kinds of meat, liver alone excepted, may be employed, and the same is true of the various fats; most authorities allow also eggs and cheese. Among vegetables Senator would permit those commonly used for salads, also cucumbers, spinach, asparagus, the different kinds of cabbage and greens, scorzonera, radishes, and even carrots and truffles in moderation, on account of the small amount of carbohydrates they contain. Among fruits he considers that only those rich in sugar, as dates, figs, and grapes, especially when dried as raisins, need be absolutely prohibited, while a number of acidulous fruits, as apples, currants, cherries, &c., can hardly do any harm, since for the most part they contain more levulose than grape sugar. These, it is true, are rather of the nature of luxuries than of food, but to the diabetic they are of great value in relieving the monotony of the meat diet.

The following must, so far as practicable, be excluded on account of the large proportion of starch and sugar in all: cereals of every kind and preparations of the same, legumens, and chestnuts. Meal and sugar must of course not be employed as adjuncts to meat soups and vegetables.[1] The continued deprivation of bread is felt most severely by all diabetics, and numerous attempts have been made to discover a substitute for this important article of food. Thus Bouchardat recommended a gluten bread, to prepare which the flour is deprived as far as possible of its starch by repeated washing. But the gluten bread, of which there are several kinds in the market, is never entirely free from starch, and some samples contain a very considerable amount; besides it can never form a true substitute for ordinary bread, being far from agreeable to the taste. Liebig has suggested another method for making a bread as nearly as possible free from starch, which consists in treating thin slices of ordinary white

[1] According to Senator it is possible that honey may not in all cases lead to an increase of the excretion of sugar, consisting as it does mainly of the relatively far less injurious levulose.

bread with infusion of malt; the starch is then converted into sugar, which can be removed by washing.

As regards the bran bread of Prout, made from bran washed as far as possible, opinions are even more unfavourable than in the case of the gluten bread, since it contains quite as much sugar-forming material; besides which the cellulose irritates the bowel and easily excites gastro-intestinal derangement; so that the utilisation of such a bread in the alimentary canal must be in the last degree imperfect. This holds good also, according to Senator, of Palmer's recipe for a bake meat prepared from washed potatoes.

Most authorities consider Pavy's almond cakes to be the best substitute for bread. By washing with acidulated water the greater part of the sugar contained in sweet almonds is removed. By judicious preparation an objection which often attaches to almond bread, viz. its hardness, may, without difficulty, be avoided; but it has yet another drawback—that the large proportion of fat renders it occasionally ill-tolerated.[1]

The use of milk is, as a rule, to be permitted in moderation only on account of the lactose, although Külz in his experiments found it to be by no means invariably injurious (see p. 296). Of the beverages which constitute so large a part of the enjoyments of the healthy, only weak infusions of tea and coffee, and these without sugar, may be taken with impunity. The question whether alcoholic drinks increase the excretion of sugar has received different answers, some observers having found an augmented excretion after the use of wine, while others have noticed no such result. Külz, indeed, in one case remarked a lessened secretion of sugar after large doses of alcohol, and in a considerable number of patients he was unable

[1] Seegen gives the following receipt for making almond bread:—A quarter of a pound of blanched sweet almonds are beaten in a stoneware mortar as fine as possible for about three quarters of an hour. The mealy mass thus obtained contains some sugar, to get rid of which it is put into a linen bag and steeped for a quarter of an hour in boiling water to which some drops of vinegar have been added. The paste is then intimately mixed with three ounces of butter and two entire eggs. Next the yolks of three eggs and a little salt are to be added, and the whole stirred well and long. The whites of the three eggs are beaten to a whip, added, and stirred in. Lastly the dough is put into greased moulds and dried by a slow fire.

to prove any ill consequences to follow smaller doses. He deems it, however, advisable to ascertain for each individual patient how he is affected by wine.[1] The light red wines appear to agree best, while obviously those which contain a large percentage of sugar (especially champagne), most wines from southern lands, all liqueurs, and beer must be avoided.

The withholding of carbohydrates is not enforced by all physicians with equal rigour, as will be seen from a comparison of some of the published regimens.[2]

In Rollo's treatment the patient is allowed for breakfast $1\frac{1}{2}$ litres of milk diluted with $\frac{1}{2}$ litre of water, with a little bread and butter; for dinner a little tender meat, a small sausage made with blood, and a fat that tends to turn rancid speedily, provided it agrees well with the stomach; for supper the same as for dinner. As a drink, water with ammonium sulphide [!] was recommended.[3]

In Bouchardat's regimen the diet consisted of meat, cream, and such vegetable foods as contain but little carbohydrates. Accordingly he allowed all kinds of meat cooked in any way desired, except that neither meal nor sugar might be added. All sorts of fish, lobsters and crabs, oysters, snails, and eggs; of vegetables especially spinach, artichokes, asparagus, cabbage, lettuce, green beans, &c.; and of fruits chiefly peaches and strawberries. As a substitute for bread Bouchardat recommended the gluten bread already mentioned. Milk was forbidden, cream only being allowed.

More recently the 'milk cure' was strongly recommended by Donkin. In the first weeks of treatment all food whatever is denied except skim milk, but the patient is ordered from five to ten pints daily, according to the circumstances of the case. Why the milk should be skimmed, Donkin, as Külz remarks, does not explain. Opinions differ as to the results of the 'milk cure,' an improvement having been noticed in some cases and none in others.[4]

[1] E. Külz, *Beitr. z. Pathol. u. Ther. d. Diab. mell. u.s.w.* Marburg, 1875.

[2] The ideas of Piorry, who sought to meet the excretion of sugar by the administration of the same substance, and also enjoined abstinence from drink, are almost unique. Among those who have put Piorry's method to the test of practice we may mention Griesinger, who expressed himself very disappointed with it (*Ges. Abhandl.*, ii. pp. 403, et seq.).

[3] From Cantani, *Spec. Path. u. Ther. d. Stoffwechselkrankheit*, vol. i. Berlin, 1880.

[4] *Lancet*, ii. Nos. 22 and 23, 1869; *Med. Times and Gaz.*, Feb. 12, 1870; *Lancet*, i. Nos. 2 and 3, 1873; see also Külz.

Düring's treatment is founded[1] on the theory that a faulty diet or habit of life, and a consequent anomalous state of the digestion, are the most important factors in the causation of diabetes, on which account a restricted diet and a selection of the most digestible foods only is insisted on. Accordingly Düring allows his patients three, or at most four, meals daily, to be taken at prescribed intervals. For breakfast he orders, as a rule, milk with a little coffee but no sugar, and stale white bread *ad libitum*. Some lime water should be added to the milk to prevent its turning sour in the stomach. If bread cannot be borne, or by way of a change, a gruel of rice, groats, or pearl barley, boiled in water, without butter and but little salt, may be taken. For a second breakfast bread and butter, white bread, stale and well baked, and, at the discretion of the medical man, a light-boiled egg, with half a glass of good red wine in water. may be allowed; but in most cases a breakfast cup of rice or oatmeal gruel with or without milk will be found to agree better. The dinner, taken between two and three o'clock, consists of a soup of the above-mentioned cereals, and 250 grammes of meat, roast not boiled; ham, smoked meats, and game are permitted, but without vinegar or condiments, and as far as possible deprived of fat. The gravy from the roast meat is allowed, but not fatty sauces; preserves of dried apples, plums, and cherries, and in some cases dried peas or white beans. Green vegetables (as asparagus, French beans, carrots, cauliflower, and cabbages) are also permitted, but they must be boiled in water only with salt, and not dressed with stock or fat.[2] For dessert a little raw fruit, as apples or cherries, with one small glass of red wine diluted with water. For supper, about seven o'clock, thin rice, groats, or barley gruel, with salt but not butter, and strained, and in some cases made with milk. The thirst and parched sensation between meals may be removed by ice or iced water.

Pavy's regimen allows all kinds of meat except liver, and cooked in any way that may be desired, or smoked, salted, or dried; and the same for all kinds of fish. He further permits soups without farinaceous adjuncts, eggs, cheese, butter, cream, and almond or gluten bread, also bran bread; of green vegetables spinach, artichokes, cress, cucumbers, lettuce, endive, radish, celery, and mushrooms; unsweetened fruit jellies are also allowed. Carrots, green beans; cauliflower, broccoli, asparagus, cabbage, nuts of all kinds except chestnuts,

[1] A. v. Düring, *Ursache u. Heilung. d. Diab. mell.* Hanover, 1880.

[2] A. v. Düring lays great weight on the mode in which the vegetable foods he recommends are dressed: cereals especially which are used for making gruel, and legumes before being cooked are to be steeped for some time and boiled long enough to make them more easily digested.

and olives may be taken in small quantities only. Cream alone or whipped with white of egg is allowed, but not milk. For drinks tea, coffee, soda water, light wines and unsweetened spirits, and bitter ale in moderation. Under all circumstances the patient must avoid sugar of every kind, wheaten bread and biscuits, rice, sago, tapioca, macaroni, potatoes, carrots and peas, and all kinds of fruits (fresh or preserved), and all farinaceous foods. Milk may be taken, though very sparingly, and so, too, port wine; but the sweet beers and highly saccharine wines, as well as all liqueurs, are prohibited.[1]

Seegen allows *ad libitum* meat of all sorts; also ham, smoked meats, and tongue; fish of every kind, as well as oysters, crabs, lobsters, isinglass, aspic, eggs, caviar, cream, butter, lard, and cheese; of vegetables spinach, boiled salad, endives, cucumber, asparagus, cauliflower, sorrel, artichokes, mushrooms, and nuts. As drinks water, soda water, tea and coffee, Bordeaux, Rhine, Moselle, Austrian, and Hungarian—in short, all light and feebly saccharine wines. He allows in moderation cauliflower, carrots, turnips, cabbage, green beans, strawberries, raspberries, currants, oranges, and almonds; in extreme moderation milk, cognac, bitter beer, almond milk unsweetened, and lemonade without sugar. Bread is ordered in small quantities at the discretion of the physician, but all kinds of farinaceous foods, sugar, potatoes, rice, tapioca, arrowroot, sago, groats, peas (green or dried) and beans, kohlrabi, sweet fruits (as grapes, cherries, peaches, apricots, plums, &c.) in the fresh state, and still more in the dry, are forbidden. So, too, are the following beverages: champagne and sweet wines, sweet beers, must, fruit wines, sweet lemonade, liqueurs, fruit juices and syrups, cacao and chocolate.[2]

The severest regimen is that enjoined by Cantani, who restricts his patients to meat and fat at all their meals; the meat may be derived from any of the vertebrata, and any of the viscera except the liver may be eaten; so, too, may all fish and lobsters. Fish and flesh may be cooked in any way that may be preferred, or smoked, dried, or salted; but no sugar, meal, or spice may be used in the process. Among fats pure olive oil and every kind of animal fat is allowed with the exception of butter, since it always contains traces of milk sugar. Cantani, indeed, urges on his patients the consumption of as much fat as possible, provided it is well digested.[3]

[1] F. W. Pavy, 'A Treatise on Food and Dietetics,' pp. 549 et seq. London, 1875.

[2] J. Seegen, *Der Diabetes mell.*, Leipzig, 1870.

[3] To facilitate the digestion of fat Cantani strongly recommends the use of 'pancreatic fat'; that is, of pancreas cut up into small pieces, well mixed with a

As a drink he allows only pure water or soda water, but persons accustomed to indulge in strong wines and spirits may add to the water 10 to 30 grammes of pure rectified alcohol in the twenty-four hours. In less severe cases Cantani permits also eggs and old light red wine, as well as small quantities of tea and coffee, but without sugar. He forbids milk, milk foods, butter, cheese, oranges, lemons, peaches, strawberries, and all other kinds of fruit, all green vegetables and roots. He absolutely prohibits all farinaceous foods, sweets, jellies, lemonades, chocolates, vinegar, rum, and Cognac, in most cases also tea and coffee. The use of salt as well as of pickled pork and salt fish must be greatly restricted, for too much salt acts injuriously. Cantani prescribes this absolute meat and fat diet for three full months, and in severer cases continues it for six or even nine; only in very mild cases will two suffice. If after two months sugar has entirely disappeared from the urine, green vegetables are allowed, four weeks later cheese and clarified old red wine, and in another fortnight almonds and nuts. A month or two after this juicy fruits not too sweet, as strawberries, raspberries, peaches, apples, and sour oranges, &c., and later plums, gooseberries, green beans and peas, tomatoes, melons, cucumbers, and gourds. After the lapse of another fourteen days Cantani prescribes milk and fresh milk foods. Lastly, if the urine after repeated examination proves to be free from sugar, small quantities of farinaceous foods are cautiously added—but their use must be limited through life—while it is best to abstain for ever from cane sugar, sweets, sweet ices, &c. For convalescents who cannot entirely dispense with bread Cantani recommends the almond cakes of Pavy as the sole permissible substitute.

As regards the quantity of food that should be allowed to a diabetic, the sense of hunger gives certain indications, although we have no satisfactory measure. It needs no proof that in the diabetic, as in the healthy subject, the waste of tissue will not cease until all the materials contained in the output are contained also in the intake. It is, therefore, clear that for those patients who excrete a large part of the food ingested in the form of sugar, and at the same time metabolise much albumen, a far larger quantity of food is required to cover the loss than is the case with normal individuals. The actual

certain quantity of melted bacon fat or lard, left to undergo an artificial digestion for about three hours, and finally lightly roasted before the fire. In mild cases of diabetes he recommends the administration of pure sugar-free cod-liver oil in doses of 20 to 100 grammes.

amounts of nitrogenous and non-nitrogenous foodstuffs used by a diabetic to prevent a loss of weight is uncommonly variable. There are persons in whom the nitrogenous metabolism is active, and who excrete sugar in large quantity on a purely animal diet, and who, consequently require an enormous amount of food to maintain even a feeble condition of body. On the other hand, in mild cases in which the excretion of sugar ceases entirely on the exclusion of carbohydrates, there is not as a rule any increased demand for nutritive matters, provided, of course, that a due proportion is maintained between the nitrogenous and non-nitrogenous constituents of the food. When, however, the diet is exclusively, or in overwhelming proportion, composed of albuminates, an extravagant quantity of these is required before intake and output cover each other, a further reason for insisting on a sufficient supply of fat.

It is quite possible that an immoderate supply of albuminates coupled with an inadequate amount of fat may exert an unfavourable influence on the excretion of sugar. At any rate, that gain of flesh which is so much to be desired in diabetics will be more surely attained if not only albuminates, but also fats, are present in the food in small excess.

Since it is not possible in every case of diabetes mellitus to carry out an exact estimation of the total intake and output with a view to ascertain whether any particular diet is sufficient to cover the loss of substance or not, we must have recourse to frequent weighings of the body to learn the effect of a course of dietetic treatment. Not less important indications are to be obtained from an estimation of the sugar and of the nitrogenous products of metabolism in the urine.

DIETETIC METHODS OF TREATMENT.

LIMITATION OF THE NON-NITROGENOUS FOOD-STUFFS. DIETETIC TREATMENT OF OBESITY.

Brillat-Savarin: 'Physiol. d. Geschmacks, oder physiol. Anleitung z. Studium d. Tafelgenüsse.' Translated by C. Vogt. Brunswick, 1865.—Wadd: 'Die Corpulenz als Krankheit: ihre Ursache u. ihre Heilung.' From the English. Weimar, 1839.—W. Banting: 'Letter on Corpulence: addressed to the Public.' London, 1864.—J. Vogel: 'Die Corpulenz: ihre Ursachen, Verhütung u. Heilung.' Leipzig, 1865.—P. Niemeyer: 'Das Banting-System keine neue Erfindung,' *Deutsche Klinik*, No. 17, 1866.—F. Daniel: 'Nouveaux Préceptes pour Diminuer l'Embonpoint sans altérer la Santé.' Paris, 1867.—Immermann: 'Handb. d. allg. Ernährungsstörungen,' in V. Ziemssen's *Handb. d. spec. Path. u. Ther.* part i. vol. xiii. 1879.—Kisch: Art. 'Fettsucht' in Eulenburg's *Realencyclopädie.* Vienna, 1881.—Cantani: 'Spec. Path. u. Ther. d. Stoffwechselkrankheiten.' German by Hahn. Berlin, 1881.—W. Ebstein: 'Die Fettleibigkeit u. ihre Behandlung.' Wiesbaden, 1882.

The desire to remove an immoderate corpulency by altered habits of living and by dietetic prescriptions has from the earliest time suggested many efforts in this direction; some of which consisted merely in a restriction of the total nourishment, while in others a particular selection of the various articles of food in common use was enjoined. The simple starvation cures are at present almost unanimously condemned as useless and injurious, but there are several methods in which a diminution of the fat deposited in the body may be effected by withholding such articles of food as are known to encourage corpulence.

The fact that a liberal use of carbohydrates favours the growth of fat in the animal body has long been known and acted on especially by farmers and cattle-breeders, and the knowledge of this fact led in course of time to the doctrine of

the direct production of fat from carbohydrates. Thus Brillat Savarin in his book on the physiology of taste, supporting his argument on these observations of animal life, describes the use of meal and starch as one of the most important factors in the production of corpulence, and urges a rigid abstinence from all farinaceous foods as the best remedy.

According to Brillat-Savarin corpulence, apart from hereditary predisposition, depends on a too farinaceous diet. One has but to look at beasts of prey, as the wolf and jackal, which never are fat, and at the herbivora, in whom the accumulation of fat follows the use of potatoes, corn, or meal. 'According to this theory every mode of treating corpulence must be based on the three following maxims—abstemiousness in eating, moderation in sleep, and active exercise on horse or foot. But little good is to be expected from these precepts while men are what they are. To rise hungry from the table demands great strength of will; to prescribe early rising to fat people is enough to break their hearts. Riding is a costly pleasure, and there are all sorts of objections to walking—it causes pains in the side and horrible perspirations. One must therefore seek another means for reducing excessive corpulency, and this is to be found in an appropriate diet, i.e. one from which the starchy foods are as far as possible excluded.'

Brillat-Savarin recommended any kind of meats, especially veal and poultry—and best roasted—with salad or green vegetables. Besides these he allowed meat broths with green vegetables, Julienne soup, rye bread, cabbage and turnips, jellies, with punch and oranges and fruits for dessert. As drinks he prescribed seltzer water or light white wine, and after dinner a little black coffee; against beer he warned his patients as against the plague. It was also allowable in most cases to take radishes, artichokes with pepper, asparagus, celery, &c.

Others laid the greatest stress on avoiding fats; thus Chambers advised for the cure of obesity a regimen in which every kind of fat and fatty food was strenuously interdicted, and a diet consisting mainly of albuminates laid down. The use of sugar was forbidden, and that of foods containing much starch, as bread, potatoes, &c., described as very questionable.

Further schemes for the cure of corpulency were suggested by the teaching of Justus v. Liebig on the *rôle* of the several foodstuffs and the formation of fat from the carbohydrates.

So Moleschott declared that in excessive corpulency it might be advisable, along with the most careful attention to the respiration, to choose a diet mainly of lean meat. He gave the preference also in the dyscrasia of drunkards to veal and game, since the supply of fatty matter to the blood might be thus limited, and the fat already deposited in excess be brought under the action of the oxygen.

The Banting system, which in its time attracted no small attention, doubtless arose also from the ideas of J. v. Liebig.

W. Banting, who suffered from extreme corpulency, had applied to several medical men for advice and relief from his misfortune; but most of them had merely advised moderation and light diet; indefinite instruction which led to no result. It was a medical man, however, named W. Harvey who taught Banting that he must avoid, so far as practicable, all foods which contained any large amount of fat, starch, or sugar, since all these tended to favour the increase of fat in the body.

Banting received from Harvey a diet sheet drawn up with the utmost precision, and excluding all fats and carbohydrates as much as possible, while prescribing albuminates, and especially lean meat, in abundance. By punctually carrying out these instructions Banting reduced his weight in the course of eight months from over 200 to 166 lbs., and the circumference of his body by 12¼ inches, an improvement in his general feelings and greater ease in movement showing themselves *pari passu* with the decrease of corpulence.

The diet that Harvey prescribed for his patient was as follows :—For breakfast 4 to 5 ounces of beef, mutton, or fried fish, for which ham or any kind of cold meat except bacon might be substituted. With it a breakfast cup of tea without milk or sugar, and an ounce of toast or a biscuit, but no butter.

For dinner 5 to 6 ounces of any kind of meat except bacon, or of any fish except [eels and] salmon, any vegetable except potatoes, an ounce of toast, any kind of game or poultry, and any preserved fruits. As a drink two or three glasses of a good red wine, or sherry, or Madeira were allowed, but champagne, port, and beer were forbidden.

In the afternoon 2 to 3 ounces of fruit, a large biscuit, and a cup of tea without milk or sugar.

For supper 3 to 4 ounces of meat or fish and one or two glasses of claret. As a 'night-cap,' if such were needed, a glass of grog made with brandy or rum.

Banting remarks that herrings and eels were excluded, on account

of their fatty character; and, of vegetables, parsnips, carrots, beet, and turnips, as well as potatoes; but cheese, taken in moderation, seemed to do no harm.

The success of this treatment, highly praised by Banting, is not without scientific interest, since it presents a carefully conducted experiment on the effects of single articles of food on the human body, the results of which seemed to be in perfect accord with the views of Liebig, who taught that the proteids are usually employed for the restoration of the tissues continually undergoing destruction in the body, while the fats and carbohydrates, on the other hand, are respiratory foods, and constitute the chief material for the production of animal heat, but that when taken in excess they lead to an accumulation of fat in the body. If, on the contrary, an insufficient amount of these respiratory foods be supplied, the oxygen in the body is compelled to act partly on the fat present in the tissues, since this is more easily oxidised than the albuminates introduced with the food. Thus the success of the Banting treatment appeared to find a simple explanation in and to furnish a brilliant confirmation of the theory of Liebig.

J. Vogel proposed several modifications of the Banting system :—

Breakfast, coffee as usual—best without milk or sugar, but a little of these will not do harm—and with it some biscuits or toast, at most a little white bread; sugar, fatty cakes, and butter to be forbidden. If the individual is in the habit of taking a substantial breakfast, one or two light-boiled eggs or a little cold meat may be added. For those who, dining late, require a luncheon this should consist of a couple of light-boiled eggs, or a little cold meat or ham, with some bread, and a glass of light wine or a cup of tea with as little milk and sugar as possible.

For dinner the best course consists of a thin meat broth without much bread, sago, &c., boiled or roast meat, and some light vegetable or preserve; but no dish should contain much fat. A couple of boiled potatoes are unobjectionable. When the digestion is good raw fruit of any kind may be taken without hesitation. After dinner coffee, best black.

For supper soup or tea with cold meat, ham, or light-boiled eggs, salad, and a little bread, according to inclination and habit. Wine in moderation is the best drink, the quality being of less importance than the quantity; also soda water; but beer is certainly injurious.

J. Vogel cannot entertain the entire exclusion of respiratory foods, nor does he think it necessary, for an excess only of these can do harm. The strictness of the regimen and the total quantity of food must be determined by the circumstances of each case; the physical condition of the individual and the amount of mental or bodily exercise practised must be taken into consideration. Those cases in which a hereditary tendency exists demand the strictest measures. Care must be taken in all cases to provide for a due variety in the diet.

In consequence of the revolution that our views on the action of the several foodstuffs have experienced since the discovery of the Banting system, the explanation of the fact that the body will under such treatment part with a considerable proportion of the fat must find another basis than that originally implied in the teaching of Liebig. The assumption that under the influence of a diet consisting mainly of albuminates the fat of the body was attacked because of its possessing a greater affinity for oxygen than albumen is irreconcilable with the results of Voit's researches. It has rather been proved that the albumen circulating in the nutrient currents is more easily subjected to metabolism than either the carbohydrates or the fats.

When a large proportion of albuminates is taken with the food the nitrogenous metabolism is accelerated, since more circulating albumen is brought into mutual relation with the cellular tissues. If together with the albumen a certain quantity of fat and carbohydrates enter the circulation less albumen is metabolised, and the fat stored up in the body produces a like effect. The lessening of albuminous metabolism in the presence of fat is not to be explained, Voit maintains, by the fat having a greater affinity for the oxygen in the body, but, he would rather suggest, that under the influence of the fat a larger proportion of the circulating albumen is transformed into organic. When, then, a highly albuminous diet is administered to an organism which has stored up much fat, a certain quantity of albumen is withdrawn from the conditions of metabolism and is laid up as organic albumen. But since the ability of the cellular elements to metabolise matter is not exhausted by the quantity of circulating albumen still present,

a portion of the fat of the body itself is subjected to metabolism. Thus successive deductions are made from the fat stored up in the body, and the increase of organic albumen becomes constantly less until it ceases altogether, while albuminous metabolism increases at a corresponding rate. It may indeed happen that after the greater part of the fat in the tissues has been consumed the albumen of the food no longer suffices to prevent the loss of albumen by the body, so that ultimately large quantities of even the organised albumen may undergo metabolism.[1]

The fact that in the course of the Banting treatment the amplest supply of albuminates does not suffice to maintain the albuminous condition of the organism points to the need for caution in the employment of this regimen for the reduction of corpulence. In fact, several cases are recorded in which a number of really serious consequences have followed the practice of this method. The instances are by no means isolated in which the Banting cure has induced a state of extreme debility; indeed, it has repeatedly occurred that the emaciation once set going has continued to advance after the treatment was stopped and a mixed diet resumed. Diseases of various organs have been observed in the course of Bantingism, and it is obvious that we have here to deal with the effects of an exclusively albuminous diet and the changes in the tissues induced thereby. In addition to this many persons acquire, as a consequence of the exclusively animal diet, a repugnance to all foods of that kind, which may lead to derangements of the digestion, with cardialgia, &c. On these and other grounds it is advisable always to employ the Banting treatment in a modified form; that is, to reduce the use of non-nitrogenous foodstuffs to moderate limits, giving at the same time a somewhat larger proportion of albuminates; and Immermann has suggested that the treatment should not be persevered in continuously, but rather be interrupted from time to time.

The evils inseparable from rigid Bantingism have recently prompted Ebstein to recommend a somewhat different treatment for the reduction of corpulence, differing from Bantingism

[1] C. v. Voit, *Physiol. d. allg. Stoffwechsels u. d. Ernährung*, p. 316 et alibi.

in allowing the use of certain fats in pretty considerable amounts, founded on the fact that carnivora on an exclusive diet of flesh and fat show very little tendency to fatty deposits. At the same time the supply of carbohydrates is reduced to very small proportions, and the use of sugar, sweets of all kinds, and of potatoes is absolutely prohibited.

It is self-evident that an organism which, from the use of a diet consisting of albumen, fats, and carbohydrates in excess of the waste, has accumulated a large quantity of fat would not lose any of this, if, instead of a diet containing little fat and much carbohydrates, an exactly equivalent amount of non-nitrogenous substances, but in which the fats predominated, were to be substituted. To reduce excessive corpulence the total supply of non-nitrogenous food-stuff must be restricted, and this is so in Ebstein's regimen. The daily allowance of fat permitted by him is 60 to 100 grammes, varying with individual circumstances and from day to day. The carbohydrates are, as we have said, allowed very sparingly, the daily consumption of bread reaches only 80 to 100 grammes, and the highly albuminous legumes are recommended. Of alcoholic drinks two or three glasses of light wine are allowed, but beer is strictly prohibited unless a corresponding reduction be effected in the other permissible carbohydrates.

While in the Banting system the use of a large amount of albuminates (360 to 450 grammes per day) is necessary, Ebstein prescribes only one half or three-fifths of this quantity without any unnatural sense of hunger being experienced; a fact attributable to the influence of the fat. Only three meals are allowed, luncheon and supper being refused; otherwise the total amount of food varies with the circumstances of the individual, especially his employment. Thus for a man forty-four years of age who, with a temperate but sedentary course of life since his twenty-fifth year, had suffered from increasing corpulence, the following regimen was ordered, under which he lost 20 pounds in half a year:—

Breakfast, a large cup of black tea without milk or sugar and 50 grammes of white bread or toasted brown bread and plenty of butter. (In winter the breakfast was taken at half-past seven, in summer at half-past six.)

Dinner between two and half-past two o'clock. Soup (frequently with marrow), 120 to 180 grammes of meat (roast or boiled) with fat sauces, a preference being given to the fattest meats, vegetables in moderation, with preference for the legumes, but the cabbage tribe

permitted. Potatoes absolutely excluded, and other roots nearly so on account of the sugar. For dessert salads and a little dried fruit without sugar. After dinner some fresh fruit.

Supper at half-past seven to eight o'clock. In winter almost regularly, in summer occasionally, a cup of tea without milk or sugar; an egg, or fat roast meats, or broth, or fat bacon, or sausage, or smoked or fresh fish, about 30 grammes of white bread with plenty of butter, and occasionally a little cheese and some raw fruit.

Ebstein insists under all circumstances on great caution in the dietetic treatment of corpulency; the reduction of weight must not be effected too rapidly, and the subjects of treatment must not feel any inconvenience from it, but rather gain progressively in capability of exertion. He rightly urges that a certain amount of muscular exercise should be combined with the treatment, with a view to remove the excess of fat, since the consumption of fat is notably greater during muscular efforts than during rest.

Some physicians have advised the employment for therapeutic purposes of the regimen followed in the training of boxers, racers, jockeys, &c., and undertaken with a view to render them capable of unusual muscular effort and prolonged endurance.[1] During training the muscles gain astonishingly in bulk, firmness, and elasticity, the skin acquires a clean, supple appearance and bright hue, while any excess of fat and water disappears from the tissues. This end is attained partly by gymnastic exercise and partly by dietetic rules.[2]

According to Pavy the most extraordinary notions formerly prevailed on this subject, and at one time emetics, purgatives, and sweatings were held to be essential to the practice of training. At present there is a growing reluctance to enforcing any too great change in the ordinary mode of life, since the health may easily be impaired by extreme measures. The regimen under all circumstances enjoins an ample use of lean meat, experience showing that this more than any other article of food aids the development of strength and endurance. An animal diet tends to the removal of any excess of water from the tissues, to lessen the deposit of fat,

[1] Dambax, *De l'Entraînement*, thèse de Paris, 1866; H. Jacquenet, *De l'Entraînement chez l'Homme au Point de Vue Phys., Prophyl. et Curatif*, thèse de Montpellier.

[2] The following directions as to 'The Diet for Training' are taken from the work of F. W. Pavy.

and to render the muscles firm and powerful; the meat should be roasted or broiled, but not too much. Some, indeed, recommend that it be taken as nearly raw as possible, since it is then most stimulating. Beef and mutton are to be preferred, but it is not necessary that all the fat be removed. Stale bread or biscuits, potatoes, and some kinds of green vegetables are allowed in moderation; watercresses are especially esteemed. On the other hand, pastry, puddings, and sweets of all kinds are forbidden; rice, sago, &c., are only allowed in small quantities. At the same time it is important to avoid a too great monotony in the diet, although it is undesirable to excite an immoderate desire for food, since an overloaded stomach is injurious. Condiments are forbidden on the ground that they stimulate the appetite, which should be maintained within its natural bounds. In former times the utmost possible limitation of fluids was thought indispensable in the training of athletes, but according to Pavy a dry diet is highly injurious to persons who lose much water by perspiration during muscular exertion. The quantity of drink should be determined by the sense of thirst, but instead of quenching it at a single draught the fluid should be taken in small and frequent doses, thus avoiding repletion of the stomach. The drinks should not be of a stimulating character; beer and light wines are allowed, but stronger alcoholic drinks prohibited. Tea and coffee may, if preferred, be taken instead of these beverages, but toast and water or barley water is recommended as the simplest of all. The number of daily meals is fixed at three. For example, the regimen followed by men training for the boat races at Oxford is for the summer races as follows:—Rising at seven, then a short walk or run. Breakfast at half-past eight of meat (beef or mutton), crust of bread or biscuit, and a little tea. Dinner at two of meat (as at breakfast) and bread, but no vegetables, as a rule, and a pint of beer. At five in the evening practice with the boats. Supper at half-past eight or nine of cold meat and bread, with a little salad or preserve, and a pint of beer. Bed at ten.

With regard to the enforcement of a mainly animal diet we may remark that such a course was recommended by Passavant in the treatment of skin diseases, and practically tested by him in the case of psoriasis; a total deprivation of fats and fat meats, such as the Banting cure prescribes, he did not consider necessary to his system, although indulgence in wine, beer, or spirits he held to be hurtful.[1] It would be useless in the present state

[1] G. Passavant, 'Die Heilung d. Psoriasis,' *Arch. d. Heilk.*, viii. 1867.

of our knowledge to seek an explanation of the way in which an almost exclusively animal diet can effect the healing of psoriasis.

LIMITATION OF ALBUMINATES. VEGETARIANISM.

From what has been already stated, there can be little doubt as to the nature of the material changes taking place in the body when the supply of albuminates is reduced. No one will dispute the statement that there are persons who take too much albumen in their food, and that many disorders of the general health may arise from this habit. It is only with such persons that when one reduces the total allowance of albuminates one withdraws the excess only, and the supply still corresponds to their real wants. It has also been shown that under certain circumstances the maintenance of a highly albuminous habit of body is undesirable, since the internal work inseparable therefrom makes demands on the functions of the several organs incompatible with a healthly state of nutrition. But in all such cases we have to do, not with a one-sided restriction of the albuminates alone, but a general reduction of the total food-supply. It is quite another question whether particular diseased conditions might not be removed or improved by a methodical limitation of the albumen while non-nitrogenous foods are supplied in abundance. Under such a diet the body would continue to part with its albumen until an equilibrium was established between the intake and output; which, however, presupposes that the supply does not fall below a fixed minimum, since otherwise the body would sooner or later perish from want of albumen. At the same time the deposit of fat in the body may increase, and in some circumstances the percentage of water in the tissues may be raised. If one would effect the absorption of a large amount of non-nitrogenous foodstuffs relatively to that of albumen, so as to alter the usual proportion between nitrogenous and non-nitrogenous foodstuffs in favour of the latter, one must have recourse to those foods from the vegetable kingdom which contain the most carbohydrates compared with albumen.

A course of diet in which as little albumen and salt of phos-

phoric acid as possible is introduced into the system has lately been suggested by F. W. Beneke for the dietetic treatment of carcinoma. In support of this view Beneke urges that the protoplasm of the cells consists essentially and in general of water, albumen, cholesterin, and lecithin, with smaller quantities of neutral fats or fatty acids, phosphates of potash and of lime, and chlorides of the alkalies; but that these constituents present in different cells a relatively different quantitative proportion there can be little doubt. As to the cells of carcinoma, Beneke believes that he may venture to assert that they are relatively rich in cholesterin (and in lecithin?). But since cholesterin is a product of albuminates, which are, again, rich in alkaline and earthy phosphates, he thinks that the growth of the tumours in question might be checked by the use of a diet which, while just meeting the necessities of the organism in other respects, shall contain the least possible quantity of the constituents specially required for cell formation—viz. cholesterin, lecithin, earthy and alkaline phosphates—and this is the case with a diet almost purely vegetable.

The dietetic directions which Beneke lays down for carcinomatous patients are as follows:—

For breakfast: A strong infusion of black tea with sugar and cream, a little bread with plenty of butter, then some potatoes cooked in their skins with butter. Cacoa may be substituted for tea.

For lunch: Fruit, raw or cooked, some English biscuits or a little bread-and-butter, and a glass of wine.

For dinner: Fruit soup or wine soup with sago or Indian corn or potato soup; not more than fifty grammes of meat, fresh minced; potatoes in the form of purée, or fricassée, mashed, or plain boiled; any kind of vegetable roots; stewed fruit, apples or plums with rice, or rice with rum (*sic.*), salads and fruit ices. Light Moselle or Rhine wines or champagne are allowed; beer, however, is only to be permitted in small quantities, on account its large percentage of alkaline phosphates.

Afternoon: Black tea with sugar and cream and a little bread-and-butter, and perhaps also some raw fruit and biscuits.

For supper: Soup as at dinner, rice with fruit, boiled potatoes with butter, or potato salad; small quantities of sardines in oil, anchovies, or fresh herrings; buck-wheat gruel with wine and sugar; light wines.

By means of diet of this composition Beneke believes that the proportion of nitrogenous to non-nitrogenous foodstuffs, which is commonly as 1 : 5, will be reduced to 1 : 8 or 9. At the same time the salts of potash will be in great part taken as tartrates, malates, &c., and only to a very small extent as phosphates, and the urine will consequently have a feebler acid reaction. The consumption of cereals, and still more of the leguminosæ, is to be restricted as far as possible.

The question whether a person can subsist on a diet so poor in albumen and phosphoric acid is answered by Beneke in the affirmative on the ground of practical experience, which proved that the persons so treated showed no loss of strength or function.[1] But on the therapeutic value of this diet we have at present only the most scanty evidence, and further observations must decide whether his suppositions are sound, there being many *à priori* objections to them.

In the regimen recommended by Beneke for carcinomatous patients the vegetable foods take the chief place simply in order that the food may contain the least possible quantity of albumen and phosphoric acid; but it is not vegetarian in principle, since regard is had only to the chemical composition of the foods and not to their derivation from the animal or vegetable kingdoms. Those persons, on the other hand, who would have that man should support himself on a vegetarian diet lay special stress on the source of the food, arguing that meat, or indeed everything derived from the animal world, is unsuited for the food of man, and consequently is prejudicial to health; that the human race, originally designed for a vegetable diet, has adopted a mixed one only under a delusion. We cannot here go further into the arguments by which vegetarians seek to support their doctrine, but must simply deny the assertion that the use of meat or other animal foods is directly injurious. At the same time we will not dispute that they can boast of some salutary effects in certain forms of disease, although their practice presents many extravagancies. It has already been shown that under certain circumstances a diet mainly vegetable

[1] F. W. Beneke, 'Zur Pathol. u. Therap. d. Carcinome,' *Deutsch. Arch. f. klin. Med.*, xv. p. 538 et seq. and 'Zur Behandlung der Carcinome,' *Berl. klin. Wochenschrift*, 1880, No. 11.

may be advisable; the best results, however, of such a vegetarian manner of living are to be seen in the case of those who have formerly indulged to excess in the pleasures of the table and in the use of stimulants, especially if they have added to these inactive or sedentary habits. The number of persons in the well-to-do classes who have in this way injured their health is not small, and with such it may be of service to limit the excessive use of meat and to substitute large quantities of vegetables, fruit, and the like. The beneficial effects of vegetarianism certainly do not depend on the fact that its followers take no meat, and still more no animal food, but on their giving up their former bad habits. We must also not forget that the transition from a diet mainly animal to one purely vegetable is not without its influence on the digestive organs, and in this connection we must not undervalue the action of bran bread, which plays a great part in the diet of the vegetarian. It has already been remarked that a regular peristalsis and periodical evacuation of the fæces exercise no small influence on the general well-being, and in many cases in which various ailments vanish on the adoption of a vegetarian diet it may well be due to the circumstance that the freer use of vegetables, and especially of bran bread, has relieved a previously existing sluggishness of the bowels.

SCHROTH'S TREATMENT. THE DRY CURE.

Galen mentions a sect of physicians who employed a 'thirst cure,' and among the Arabians the 'dry cure' seems to have been occasionally practised; at least in their older literature we read of a *diæta sicca*. Recently several systems of methodical dry cures have been taken up, of which we may name especially the dietetic practice of the yeoman John Schroth, the 'Arabian cure' for inveterate syphilis, and the so-called 'lemon cure.' There can be no doubt that the limitation of fluids is a powerful agent, which, rightly directed, can achieve certain therapeutic successes, which, however, must not be estimated

from the standpoint of fanatical exaggeration, but be brought into the light of scientific criticism.

The Schroth treatment consists essentially in a dry diet, in which the only drink allowed is a little wine combined with warm moist packing of the body. The treatment begins with a preliminary course, in which the patient's usual mode of life is gradually changed and the supply of fluids restricted. Then follows the strict treatment, in which for as many consecutive days as possible no fluids whatever are allowed except one small glass of hot wine morning and evening. For dinner some thick boiled vegetables, dry and seasoned only with butter and salt, are given ; beyond this the patients must be content with dry white bread. If very intense thirst is felt they may at the end of the third or fourth day have one or two glasses of hot wine, and on the following day a pause is made in the treatment. Then the patients are allowed a glass of wine in the morning, for dinner a pudding with wine sauce, and two or three hours after this meal wine may be drunk till the thirst is quenched. After this a three or four day course of dry treatment is gone through, again to be followed, as before, by a day on which drink is allowed.

The attendants in Schroth's establishment themselves admit that during the severe treatment the patients endure no small sufferings, that febrile symptoms are induced, the appetite is lost, and great prostration is observed. All these symptoms should, however, speedily disappear at the end of the treatment and materially aid the recovery. If the severe treatment have not produced the desired result, or if it has been but imperfectly carried out, it must be repeated after an interval. During this interval the transition to a mixed diet of meat and vegetables must be effected gradually, and the second course of strict treatment must be resorted to as gradually.

If after the strict treatment has been repeated once or twice the desired curative result appears to have been attained, the after-treatment is commenced, the aim of which is to enable the patient to return by slow degrees to his ordinary mode of life, as was also done during the interruptions or intervals of the cure.

Jürgensen undertook the task of putting the system of Schroth to a scientific test after Bartels had previously made some observations in this direction, and had come to the conclusion that one probable consequence of the treatment was the concentration of the blood serum and acceleration of dif-

fusion between the blood and the fluids of the parenchyma. An opportunity for such observation was furnished by a patient with gastro-ectasis, who had derived benefit from the treatment in a so-called Schrothian institute, which Bartels attributed to the relief of the congestion of the stomach attending the catarrh through the deprivation of fluids.[1]

Jürgensen departed from the strictly Schrothian diet in allowing the patient under observation from $\frac{1}{3}$ to $\frac{2}{3}$ lb. of meat as free from fat as possible, half a bottle of light French red wine, and dry white bread *ad libitum*. This change in the regimen was ordered with the view of avoiding any mischievous consequences, since scorbutic symptoms had on a previous occasion shown themselves in a patient in the academic hospital at Kiel, who was kept throughout the whole course of the Schrothian treatment without animal food, and fatal cases of scurvy had occurred in Schroth's own establishment. Jürgensen, moreover, made his patients keep their beds enveloped in one to three sheets well wrung out in hot water.

As to the changes in the blood which Jürgensen noticed in consequence of the above-mentioned regimen, he ascertained in the first place an increase of the soluble constituents in a given weight of the serum and an increase in the specific gravity. Next he found the blood richer in corpuscles on one occasion, but poorer on others. The urine was diminished in quantity from the beginning, rapidly at first, but afterwards more slowly, while the specific gravity rose to 1·035 at the maximum. As regards the excretion of urea it sometimes equalled the average of persons under ordinary diet, while in others it exceeded or fell short of the normal amount. Bartels assumed a retention of urea in the body of a patient under his care, who received no meat, but dry bread only, and had manifested a considerable elevation of temperature, because after the termination of the treatment the excretion of urea showed a marked increase.[2] But Jürgensen has expressed his dissent from this conclusion, since the extreme solubility of urea seems inconsistent with such an occurrence so long as the kidneys are intact. As to the excretion of uric acid it can only be stated with certainty that by the second or third day of the strict treatment copious deposits appear, obviously due to the

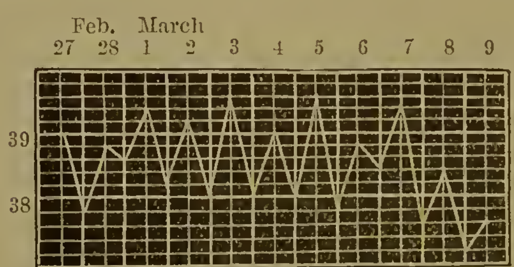
[1] Th. Jürgensen, 'Ueber d. Schroth'sche Heilverfahren,' *Deutsch. Arch f. klin. Med.*, vol. i. 1866.

[2] Bartels has recently made a communication on the value of a dry diet in dilatation of the stomach to the meeting of naturalists at Frankfort.

concentrated state of the urine; for there was no actual increase of the excretion.

During the employment of the said diet the weight of the body steadily decreased, but rose again in the intervals, and at last exceeded the point at which it stood at the commencement of the experiment. The increase of weight immediately on the breaking off of the dry diet depends, however, according to Jürgensen, on the restoration of the original amount of water in the tissues, though subsequently there was in the cases observed an actual gain of substance. But the loss of weight during the dry diet cannot be referred entirely to the loss of water; there must be a real reduction in the constituent materials of the body, since from the first withholding of fluids the patients take daily a less proportion of solid food. One patient watched by Jürgensen consumed at first twelve dry rolls daily, but came down to two or three.

It is clear that nitrogenous metabolism must be increased in patients undergoing the Schrothian treatment, since with an insufficient diet they excrete with the urine an equal or even a greater amount of the products of the metabolism of albumen than normally nourished individuals. The chief cause of this increased consumption of albumen is doubtless the elevation of temperature which almost invariably accompanies the Schrothian cure. Thus too is explained the observation of Bartels, who noticed a far more copious excretion of urea after than during the treatment, obviously a post-febrile increase in the elimination of urea. In the patients observed by Jürgensen the elevation of temperature was not so marked as is often the case. The curve here described shows the course of the temperature in a patient suffering from articular rheumatism.



The 'dry cure' was begun on February 27. On the earlier days the temperature in the morning was from 37·2° to 38° C., and in the evening from 38° to 38·6° C. Ordinary diet was resumed on March 5 at noon. The elevation of temperature continued, nevertheless, for several days after the treatment had been given up.

It was remarkable how after about 200 cubic centimetres of water had been given the temperature immediately sank as much as one degree centigrade. Jürgensen considered gastric catarrh inadmissible as an explanation of the pyrexia.[1]

[1] The elevation of temperature in the Schrothian cure depends probably on a retention of heat caused by the wet packing, and must be the more considerable since the loss of heat by the lungs and by the urine must be under the normal in consequence of the deficiency of water in the tissues.

The subjective sensations of the patients at the commencement of the treatment were not much altered, but later severe thirst set in, becoming at last intolerable. Jürgensen could find no evidence of any appreciable absorption of water by the skin.

The curative effects of the Schrothian practice were, so far as the experience of Jürgensen extended, by no means brilliant, although some inveterate cases of syphilis were cured and a chronic case of articular rheumatism with effusion into the right knee-joint was improved. The best results were achieved in gastro-ectasis and chronic peritoneal effusions, but the treatment could not be borne by all patients. Finally Jürgensen describes the Schrothian cure as a system of starvation, in which first water and then the solid constituents are abstracted from the body; the temperature too always rises, even to 40° C. (104° F.), and through the incautious employment of the treatment scorbutic symptoms may supervene. The Schrothian cure is, then, no indifferent matter, and is one the employment of which is only justifiable under peculiar circumstances.

It is at least open to question whether all the details prescribed by Schroth are absolutely essential to success; especially must the artificial elevation of the temperature to 40° C. or thereabouts be, in our present state of knowledge, deprecated. At any rate such a heroic practice as that of Schroth certainly is, can be suitable only for a few special cases; as a rule gentler forms of the dry cure, combined with a moderate employment of diaphoresis, should have the preference. A simple limitation of the use of fluids is a dietetic maxim from which many theoretical and not inconsiderable benefits may be expected in a number of diseases, especially in gastro-ectasis, in several affections of the heart and vascular system, in emphysema of the lungs, &c. On the other hand a reduction of the supply of fluids is found by experience to be especially hurtful in diabetes mellitus and insipidus, as well as in the granular form of Bright's disease of the kidneys.

THE GRAPE CURE.

L. von Babo and Metzger: 'Die Wein- u. Tafeltrauben der deutschen Weinberge u. Gärten.' Stuttgart, 1851.—Kaufmann: 'Die Traubenkur in

Dürkheim a. d. Haardt.' Berlin, 1862.—E. Huber: 'Ueber d. Gebrauch d. Weintrauben zu Neustadt a. d. Haardt,' 1853.—Schneider: 'Ueber Wasser-, Molken- u. Traubenkur zu Gleisweiler.—R. Fresenius: 'Chemische Untersuchungen der wichtigsten Obstarten,' *Ann. d. Chemie*, by Liebig and Wöhler, vol. ci.—Crasso: 'Aschenanalysen von Traubensaft,' *Ann. d. Chem.*, vols. lvii. and lxii.—Curchod: 'Essai théorique et pratique sur la Cure de Raisins.' Vevey, 1860.—Schirmer: 'Theoret. und prakt. Versuch über die Traubenkur von Curchod.' Translated by Schirmer.—A. Schulze: 'Die Weintraubenkur,' 3rd edit. Quedlinburg.—J. G. Bierfreund: 'Montreux au Lac de Genève: Considérations sur la Cure des raisins.' With one plate. Bâle.—Lersch: 'Die Kur mit Obst, Malzextract u. Kräutersäften mit neuen Analysen der Asche d. Traubensaftes.' Bonn, 1869.—Knauthe: 'Die Weintraube in histor., chem., physiol. u. therap. Beziehung.' Leipzig, 1874.—R. Hausmann: 'Ueber die Weintraubenkur mit Rücksicht auf Erfahrung in Meran,' 1873; 2nd edit. 1881.

The physicians of antiquity—Celsus, Dioscorides, Pliny, and others—allude to the curative value of grapes, and the free use of grapes has been enthusiastically recommended by several of the moderns, as Bonet, Tissot, P. Frank, &c., in certain diseases.

It is, however, but recently that any methodical grape cure has been attempted. By a methodical grape cure we understand the regular daily consumption of a stated weight of grapes continued for a long period and combined with a certain diet. The quantity of grapes to be consumed daily ranges in the majority of cases between three and eight pounds, but in some this is found to be too much and only one or two pounds are given. It is also advisable to begin the treatment with the smaller quantity—say one or two pounds daily—and gradually to increase it, and in like manner to leave off the use of the grapes at the end of the cure by degrees and not all at once. The daily allowance of grapes is usually divided into three, but occasionally into four portions, of which the first is taken in the morning an hour before breakfast, the second in the course of the forenoon, the third between 3 and 5 P. M.; and perhaps a fourth after supper. The stones and skins are of course to be rejected, since they are indigestible and may cause serious mechanical irritation of the alimentary canal.

From a large number of analyses J. König gives the following as the mean composition of grapes: water, 78·17 per cent.; sugar, 14·36 per cent.; free acid, 0·79 per cent.; nitrogenous matters, 0·59 per cent.; non-nitrogenous extractives, 1·96 per cent.; woody fibre and

stones, 3·60 per cent.; total ash, 0·53 per cent. In the several analyses the water varied between 71·93 and 84·87 per cent., the sugar between 9·28 and 18·70 per cent., the free acid between 0·49 and 1·36 per cent., and the ash between 0·33 and 0·70 per cent. The total dry substance in the different kinds of grapes was given by several analysts as follows: muscatel, 11·46 per cent.; green sylvan, 12·32 per cent.; Gutedel, 12·92 per cent.; Burgundy, 15·73 per. cent.; Riessling, 15·92 per cent.; Ruland, 15·99 per cent.; Tramine, 16·04 per cent.; blue sylvan, 17·43 per cent.[1]

The proportion of the several constituents varies in the different kinds between pretty wide limits; besides which the season, aspect, soil, and manure employed all exert a certain influence. The following percentage composition has been given for the ash of the grape: potash, 63·14 per cent.; soda, 0·40 per cent.; lime, 9·05 per cent.; magnesia, 3·97 per cent.; oxide of iron, 0·06 per cent.; phosphoric acid, 10·42 per cent.; sulphuric acid, 5·61 per cent.; silicic acid, 4·11 per cent.; chlorine, 1·01 per cent.[2]

Although grapes are distinguished from most other fruit by the very large proportion of grape sugar they contain they cannot serve as the sole article of food, since the need for albumen would not be nearly satisfied though enormous quantities should be consumed. If one assume that 0·59 gramme of albuminoid substances is contained in 100 grammes of grapes, only 17·7 grammes would be taken in six pounds of grapes. It has been noticed how soon the labourers in the vintage who take little food beyond grapes lose strength. Thus those methods in which the only other food allowed was a little bread have been generally abandoned. The effects produced by the treatment on the general nutrition are therefore very greatly dependent on the quantity of different foods taken at the same time.

In order to understand what effects the daily consumption of several pounds of grapes in addition to other food is likely to exert on the system one must first realise the quantity of water and grape sugar thus taken. The ash and the free acid contained in the grapes may have a certain influence; but at the same time we may well believe that the use of such large quantities of grapes must modify the state and activity

[1] From König and others. [2] From Knauthe and others.

of the digestive organs, and through them the proportion of nutriment absorbed.

Knauthe states that the use of such quantities of grapes or of grape juice excites at first a sense of fulness and inflation of the stomach, hiccough, palpitation, a full, frequent pulse, giddiness, and sensation of pressure in the head, restless sleep, languor, loss of appetite, and increased secretion of urine. Several observations have been made on the specific gravity of the urine and on the excretion of urea, uric acid, and phosphoric acid, but have given no uniform results; and naturally so, since the other diet has received insufficient consideration. Mialhe and Lersch have noticed that during the liberal use of grapes the urine became less acid or even alkaline, whereas Kaufmann always found it acid.

In the course of the medicinal use of grapes there are usually several semi-fluid evacuations daily, a not unimportant point in the effects of the treatment. There are indeed no direct observations recorded as to how far this increased peristalsis affects the utilisation of the food, but it is very probable that the gentle laxative action of the grapes is the reason why, when used in a particular way, they act in the way of a solvent or starvation cure. With the advent of more copious stools the inconveniences which the excessive consumption of grapes produced at the commencement usually disappear and the appetite improves. The aperient action is more marked when the grapes are taken while fasting, also in cold weather—that is to say, when the grapes themselves are cold. The use of cold grapes may even induce pains in the stomach, according to Hausmann.

It is admitted by most physicians who have had any experience of the grape cure that, incautiously practised, it may lead to dyspepsia, intestinal catarrh, and under certain circumstances icterus, although such unfortunate results can generally be avoided by observing the necessary precautions. There are, however, some individuals in whom even the most careful employment of the grape cure sets up gastric disturbance.

If one assume that a man completely satisfies the demands of his organism for nitrogenous and non-nitrogenous foodstuffs by means of a mixed diet, or receives therewith a sufficient

quantity of albuminates, it will be quite possible that the consumption of several pounds of grapes daily in addition to a diet in itself adequate may effect an increase of body-weight—that is, provided the absorption of the nutriment by the bowel be perfectly performed. The value of such a treatment, apart from its influence on the digestive apparatus, the quantity of earthy salts taken, and the lessened acidity of the urine, must be sought in the large amount of carbohydrates, especially grape sugar, added to the food. It would probably be impossible for anyone to take daily for several weeks some hundreds of grammes of grape sugar in any other form than that of agreeably flavoured grapes. While, then, the grape cure, if it be combined with a sufficient amount of other food, may well serve to improve the general nutrition, it must act more or less as a starving treatment if the diet be otherwise restricted. It may withdraw albumen or fat, or both, from the body even after the proper proportion of the foodstuffs has been restored, and the more so the more the laxative action of the grapes comes into play.

As regards the diet to be prescribed during the grape cure we may state that as a general rule all those foods which call for energetic digestive action, or which easily induce distension of the stomach, are to be avoided. As such we may consider all fat or tough meats, fatty farinaceous foods, hard-boiled eggs, cheese, pickled meats, fat fish, black bread, potatoes and other roots, &c.; beer too is generally interdicted. According to Hausmann the use of milk must not be suspended during the grape cure in the case of persons with lung affections and others to whom milk is specially useful.

From the account of Hausmann the patients at Meran are advised to take along with the grapes several figs or pears, so as to diminish the repugnance felt to one single kind of fruit; the irritation of the mucous membrane of the mouth and throat which the grapes are apt to produce is at the same time relieved. The same authority recommends that patients should, while eating the grapes, take from time to time a small piece of fine white bread, to remove the acid adhering to the teeth, and it is found by practice that the unpleasant effects of the grape juice on the mucous membrane of the stomach are thus avoided. Only in the case of obesity should this practice be neglected.

The grape cure may, as experience shows, be employed with

advantage in several forms of disease, but it is most suited to cases in which symptoms of so-called abdominal plethora are present. By a grape cure in which 5 to 8 pounds of the fruit are taken daily, while a diet in other respects moderate is prescribed, and the fats and carbohydrates limited, much of the superfluous fat may be removed, while at the same time derangements of the abdominal viscera, irregularity of the bowels, congestion of the head, &c., disappear. The happy results attained in such cases are mainly attributable to the gently laxative action of the grapes. In virtue of this effect the grape cure is adapted to other cases in which a derivation from the alimentary canal appears indicated, as hyperæmia of the liver, some diseases of the heart, habitual constipation, &c.

In other affections of the digestive organs, especially in chronic catarrh of the gastro-intestinal mucous membrane, as well as in the dyspeptic phenomena attending anæmia and chlorosis and those consequent on over-application to business, the grape cure has given good results. But in all these cases the general diet must be carefully regulated, especially as regards the quality of the food, and only a moderate amount of grapes—viz. one or two, or at most three pounds—must be taken.

The use of the grape cure is also to be recommended in several general disorders of nutrition of a different character, and in some diseases of single organs, as in the cachexia following malaria, scrofula, scurvy, gout, and concretions in the urinary passages, also in effusion into the pleura, pulmonary emphysema, and chronic bronchial catarrhs, uterine infarction, gall-stones, and in some skin diseases. It is also very efficacious in catarrh of the bladder, a fact to be ascribed to the dilution of the urine and reduction of its acidity.

The question whether the grape cure can be employed with benefit in consumption is answered affirmatively by most physicians, but it must be clearly understood that only certain cases are suited thereto, and that even in these great caution must be observed. The patients should not lose, but gain, in weight during the treatment, and to ensure this result only small quantities, i.e. one or two pounds, of grapes must be given daily, in combination with a diet amply adequate to the purpose. With such quantities the laxative action is not observed unless the digestive organs be already involved by the disease previously to the commencement of the treatment. Apart from the fact that by the consumption of one or two pounds of grapes daily a not inconsiderable quantity of easily absorbed grape sugar is ingested, the grape cure exerts an influence on the phthisical process in the lungs, since the grape juice stimulates the mucous mem-

brane of the throat, which extends to the air passages, and assists the expectoration, &c.—in other words, favourably influences the bronchial catarrh.

MILK AND WHEY CURES.

Karell: 'Ueber die Milchkur,' *Petersburg. med. Zeitschr.*, vol. viii. 1865, and 'De la Cure de Lait,' *Arch. Génér.*, Nov. and Dec. 1866 (a French translation of the preceding).—Pécholier: 'Des Indications de l'Emploi de la Diète Lactée dans le Traitement de Diverses Maladies, et spéc. dans celui des Malad. du Cœur, de l'Hydropsie et de la Diarrhée,' *Montpellier Med. Theses*, xvi. April 1866.—Pautier: 'Emploi de la Diète Lactée et de l'Oignon Crû dans l'Anasarque,' *Gaz. Hebdom.*, No. 39, 1866.—Dejust: 'Des Applications Thérap. du Lait.' Thèse de Paris, 1866.—'Des Laits Médicament,' *Gazette de Hôpitaux*, No. 45, 1866. See also Canstatt's *Jahresbericht*, 1865, vol. v. p. 131.—Ad. Leclerc: 'De l'Aliment. Lactée.' Thèse de Strasbourg.—Arthur Scott Donkin: 'On a Purely Milk Diet in the Treatment of Diabetes mellitus, Bright's Disease, &c.,' *The Lancet*, 1869.—Lebert: 'Ueber Milch- und Molkenkuren und über ländliche Kurorte für unbemittelte Brustkranke.' Berlin, 1869.—J. Berg: 'Ueber Milch und Molken u. ihre Bedeutung als Nähr- und Kurmittel.' Berlin, 1870.—Weir Mitchell: 'On the Use of Skimmed Milk as an Exclusive Diet in Disease,' *Philad. Med. Times*, Oct. 15, 1870.—Grünberg: 'Die Saisonkuren mit Milch und deren Präparaten.' Bonn, 1869.—B. M. Lersch: 'Die Kur mit Milch (Molken, Kumyss).' Bonn, 1869.—Meyer Ahrens: 'Interlaken als klimatischer und Molkenkurort.' Bern, 1869.—W. Winternitz: 'Ueber methodische Milch- u. Diätkuren,' *Wiener med. Presse*, 1870, p. 5, &c.—Balestreri: 'Sulla Dieta lattea nelle Malattie giudicate incurabili,' *Ann. Univers. di Med.*, p. 485, 1872.—Kisch: 'Neue Literatur über Milchkuren, Kisch's *Jahrb. f. Balneol.*, 1875.—Drescher: 'Milch u. Molken,' ibid. 1879. Beneke: 'Die Rationalität der Molkenkuren,' 1853.—Pletzer: 'Bad Kreuth u. seine Molkenkuren,' 1875.—H. May: 'Zur Existenzfrage d. Molke,' *Aerztl. Intell.-Bl.*, No. 12, 1879.

In the earliest ages milk was employed as a remedial agent, especially in the treatment of phthisis, in which Hippokrates advises to begin with asses' milk and later to pass on to that of cows. Milk was much esteemed in other diseases, as gout, and a strong preference was expressed by some physicians for that of the ass. Galen recommended that the animals should be fed on particular medicinal herbs, with a view to imparting their virtues to the milk. There can be little doubt that even then particular places noted for the beauty of their situation and the richness of their pastures were recommended to the

sick as resorts for the use of the milk cure. On the authority of Rhazes milk was much used by the Arabian physicians as a remedy in phthisis. In modern times Fr. Hoffmann appeared as the great champion of the therapeutic employment of milk, and sought to strengthen his position by numerous appeals to the older medical literature. In the year 1831 S. A. Chrétien, of Montpellier, published a number of observations on the efficacy of the milk cure in dropsy, and his successor Serre d'Alais reported over 60 cases of dropsy of the most various kinds in which the milk cure had been employed with very favourable results. He also gave the first precise directions as to the manner of its use, in which great stress was laid on the advantage of eating raw onions after every dose of the milk. The report of Serre d'Alais was so favourable that his assertions must be taken with a certain amount of caution, although his observations do not lack abundant confirmation.[1]

Notwithstanding the therapeutic successes obtained by several observers by means of the milk cure it attracted but small attention on the part of physicians until Karell recommended this treatment for a number of chronic diseases. At the same time it was urged by Karell that the necessary conditions of success do not lie in the use of the milk alone, but in the rigid carrying out of the method he prescribes.

In the milk cure recommended by Karell every other form of nourishment is, as a rule, and especially at the commencement, excluded, and the treatment must be practised with care, the patient receiving three or four times a day, at strictly prescribed intervals, from half to a whole coffee cup (i.e. 60 to 180 grammes) of skimmed milk. The quantity prescribed should be swallowed lukewarm, the vessel having been warmed by immersion in hot water; in warm weather most patients prefer it at the temperature of the room. Only good and perfectly neutral milk should be used. The quantity of milk begun with is gradually increased, care being taken that the digestion is not overtaxed. When the treatment is fairly begun the patient takes the milk regularly at 8 A.M., at 12 P.M., at 4 P.M., and at 8 P.M., so that four hours elapse between one meal and

[1] These historical remarks are taken from the treatise of Karell on the milk cure.

another. They do not in Karell's experience complain either of hunger or thirst, although at first the allowance of milk is but small.

Karell maintains that the success attending this treatment cannot be ascribed to the reduction of the food in itself, for no such effects follow when such patients are confined to the same amount of nourishment in the forms of bouillon or of bread and water. He has further shown that the result of the treatment is less favourable when even once in each day the use of any food other than milk is permitted.

It may happen that patients who have gradually risen to twelve glasses of milk daily may experience a return of their symptoms; in such cases the allowance should be at once reduced to four.

In the first stage of the milk cure it is usual for constipation to show itself, but this is to be regarded as a hopeful indication of tolerance of the milk; an enema of water or a dose of castor oil or of rhubarb will relieve it. But if later on in the course of the cure obstinate constipation come on the patients should take coffee with the morning's milk, or some stewed plums or roast apples with the 4 P.M. meal. Distension, diarrhœa, &c., are usually due to the quality, i.e. the richness, of the milk as regards fat, or too large doses may be the cause. When the milk is of a proper quality, and given in quantities suited to the case, the diarrhœa usually ceases, unless indeed there be ulceration of the bowel. Fever is not, in Karell's opinion, any contra-indication to the use of the milk cure; only in such cases one must proceed cautiously and increase the doses slowly.

If the patient complains of thirst he may have spring or natural Selters water. If there be an intense longing for solid food Karell allows, after the second or third week, of a little stale white bread and salt, or a small piece of Dutch herring, with that dose of milk which is taken at an hour nearest the patient's former dinner time. In the later stages of the cure milk gruel may be substituted for the milk.

After the patients have been for five or six weeks continuously fed on milk alone in the manner described the treatment may, if expedient, be prolonged in a modified form, the number of meals composed of milk alone being reduced to three, while

one of other and solid food is substituted. Karell recommends for feeble persons especially raw meat, which, freed from fat and gristle, carefully chopped, flavoured with salt, in the form of the so-called 'raw beef-steaks,' and together with bread, is as a rule willingly taken.

Karell does not attempt to answer the question as to how the efficacy of a systematic milk cure is to be explained, but leaves this to future investigation. Nevertheless it remains an indisputable fact that in certain diseases a methodical use of the milk cure gives results such as can be attained by no other treatment. It may be employed with more or less favourable results in dropsy of all kinds, obstinate dyspepsias, severe disturbance of the nervous system of hysterical or hypochondriacal origin, also in neuralgias when these stand in some relation to abdominal disorders, and in hyperæmia of the liver, but especially in anomalies of the general nutrition. Even in organic heart-disease, in advanced liver-affections, and in the later stages of Bright's disease a certain improvement —that is to say, a lessening of the dropsy—is in some cases effected for a long time. As a general rule Karell promises the most favourable results when the disorder is chiefly one of the digestive organs. In advanced pulmonary tuberculosis, i.e. when accompanied by tubercle of the bowel, no appreciable benefit is to be expected.

The successes claimed for the milk cure by Karell in particular diseases have been confirmed by F. v. Niemeyer and Winternitz. Other favourable results have been published by Pécholier, who gave the milk every two hours and carried the daily quantity as high as three litres. No other food or drink was allowed until after improvement had well set in, when a little bread soup was given and the patients returned very gradually to their ordinary diet. The forms of disease in which Pécholier found the milk cure most useful were the same as those in which its efficacy had been already proved by Karell.

Weir Mitchell arrived at very similar conclusions after employing the milk cure not only in gastric disorders, diarrhœa, dropsy following malaria and that from kidney disease, but also in several cases of nerve-disease. He gave the milk skimmed, either warm or cold as preferred, and when there was a great

objection felt to the taste he allowed the addition of some coffee, caramel, or salt.

Weir Mitchell directs very small doses to be given at the commencement, one or two tablespoonfuls of skim milk every two hours, since larger doses may induce nausea and aversion to the treatment. Each dose is then increased by one tablespoonful every day, so that on the third day the whole quantity taken is about 16 ounces. After this larger portions may be taken at longer intervals.

The pure milk diet should be persevered in for three weeks, after which a thin slice of white bread and later some rice or arrowroot may be added. In the fifth week the patient gets one or two cutlets daily, and after the sixth he passes gradually to a mixed diet, which, however, must for several months consist largely of milk.

In no case did Weir Mitchell ever observe a gain of flesh at the commencement of the treatment, and in some, very fat persons, the loss of weight continued even when the consumption of milk was at its maximum. The tongue was lightly coated, though this does not indicate any disorder of the stomach. The stools acquired after 48 hours the colour of milk, and as a rule there was a tendency to constipation; only when the milk was not well borne was there any diarrhœa. In a few cases of dropsy the milk acted as a diuretic. The pulse was usually accelerated at first, but in patients with hypertrophy of the left ventricle or palpitation the milk rendered the heart's action more steady. There were seldom any conspicuous nervous symptoms, except occasionally a strong tendency to sleep.

Favourable results followed the employment of the milk cure in the hands of H. Lebert in severe affections of the stomach, especially in ulcer of that organ. On the other hand he could not see any better success than from other modes of treatment in a combination of the milk cure with warm baths in parenchymatous nephritis. In chronic diseases of the lungs Lebert would not hear of the exclusive use of the milk cure; he would merely have such patients take a certain quantity of milk, believing it to be a very suitable food, and, combined with others, calculated to effect an improvement of the general nutrition.

Lebert directs the patient to drink slowly 300 to 500 grammes of milk every morning and evening between five and six o'clock fasting. He prefers it freshly drawn from the cow, and if, in consequence of having stood for some time, a separation of the cream have already begun recommends it to be skimmed off.

During the continuance of the milk treatment the patients are allowed a substantial dinner, at least, of soup, roast meat, young vegetables, stewed fruit, &c., and a little beer or wine. At the discretion of the physician a proper breakfast may be taken, an hour after the morning's milk, of a cup of tea with plenty of milk and biscuits, and perhaps one or two light-boiled eggs, and again in the evening a good soup as well as, when possible, i.e. in the case of non-febrile patients, some more roast meat. If milk is well borne the regular breakfast and supper may be supplemented by further doses of 100 to 200 grammes of milk.

Such an employment of milk in conjunction with climatic treatment ought, in Lebert's opinion, to take the place of the whey cures, the efficacy of which he greatly questions.

Lebert considers that it is not unimportant to have at one's disposal at places of climatic treatment the milk of asses, goats, and sheep, since these milks have different compositions and may better satisfy various requirements than that of cows alone.

The efficacy of those milk cures in which a certain quantity of other food is given at the same time depends clearly, to a great extent, on the fact that such a diet is capable of favouring an accession of body weight. It is quite otherwise with those milk cures in which for a long time no nourishment excepting milk is allowed; of the success attending them in diseases of the digestive organs some conception is possible, but no satisfactory explanation can at present be given of their *modus operandi* in the other diseases above mentioned.

Milk does not constitute a perfect and sufficient food for adults under normal circumstances, since to meet the requisite 18·3 grammes of nitrogen 2,905 grammes of milk would be necessary, and for the 328 grammes of carbon, 4,652 grammes of milk. The nitrogenous and non-nitrogenous constituents are thus not present in the proportions that have been proved most adapted to the wants of man. Besides it is a fact that the constituents of milk are not so well assimilated in the alimentary canal of the adult as are those of other

animal foods. But this does not exclude the presumption that the particular combination of the foodstuffs found in milk may, under certain pathological conditions, be the most eligible for satisfying the demands of the organism, and that the digestion and utilisation of milk may under these circumstances be more perfect than that of those foods which are more easily assimilated in health. On the scanty allowance of milk with which Karell and others commence their treatment the body must of necessity lose weight, though later on, when the quantity given is much greater, there may be a gain, greater or less according to the constitution of the individual.

The amount and composition of the ash of milk can in the present state of our knowledge hardly be appealed to for an explanation of the results of the milk cure. One would rather suggest that milk differs from other animal foods in being poorer in those matters which act as stimulants on the nervous system.

The milk serum left after the precipitation and separation of the casein, fat, &c., commonly known as whey was also used medicinally in ancient times, though the curative employment of whey and the conduct of establishments for the practice of the whey cure date from the middle of the last century.[1]

Whey is prepared in several ways; it contains generally the milk sugar, the greatest part of the salts, and small quantities of albumen and peptone-like bodies.

From 32 analyses of wheys, differently prepared, J. König obtained the following mean composition :—

	Per Cent.
Water	93·31
Albuminates	0·82
Fat	0·24
Milk sugar	4·65
Lactic acid	0·33 [2]
Salts	0·65

In order to compare the proportions in which the several constituents exist in milk and in whey the following analyses by Jul. Lehmann of goat's milk and of the whey from the same will be of use :—

[1] According to J. Braun (*Lehrb. d. Balneotherapie*, p. 506) the value of whey consists in its superseding the use of all kinds of starch and providing the necessary carbohydrates in the form of milk sugar.

[2] Lactic acid is certainly not always present in those wheys which are used medicinally.

	Goat's Milk	The Whey from the same
Water	88·39 p.c.	93·76 p.c.
Albuminates	2·78 „	0·58 „
Fat	3·84 „	0·02 „
Milk sugar	4·25 „	4·97 „
Salts	0·74 „	0·66 „

The ash of goat's whey has, according to Lehmann, the following composition :—

	Per Cent.
Potash	44·58
Soda	7·18
Lime	5·99
Magnesia	2·48
Phosphoric acid	13·78
Sulphuric acid	2·42
Chlorine	30·41

The ash of whey consists therefore mainly of potassium chloride (49·94 per cent.) and potassium phosphate (21·04 per cent.)

Taken in small doses whey produces no particular effects, but when drunk in larger quantities ($1\frac{1}{3}$ to 2 lbs. or more daily) it causes increased action of the bowels, occasionally watery stools with abdominal pain, and in some persons a lessened appetite or even well-marked dyspeptic symptoms. On this account the use of large quantities of whey has been very generally abandoned in favour of moderate doses of 500 grammes daily. Whey further acts as a diuretic, and that, according to some observers, not merely in virtue of the water but as a direct consequence of the salts it contains. To these, and especially to those of potash, H. May ascribes the fact that whey induces symptoms not unlike those noticed after the use of wine, especially increased action of the heart and temporary acceleration of the pulse. Lastly, it is said that whey relieves irritable cough and favourably influences the secretion in the bronchi.

In endeavouring to explain the therapeutic action of whey some have looked to the mere quantity of milk, sugar, and salts present, while others have insisted more on the influences exerted by these on the digestive organs. Beneke views whey as a food poor in nitrogen, and the whey cure as a form of diet in which milk salts and milk sugar are absorbed by the

organism without a corresponding amount of albuminates. But even supposing any advantage to accrue therefrom we must remember, as J. Braun has urged, that in whey cures we are not dealing with an exclusively whey diet, and that over and above the whey the patients take as much food, nitrogenous and non-nitrogenous, as their needs require.

The quantity of organic foodstuffs which is taken in whey is certainly small, but it is highly probable that they are presented in a state of solution and a form easily absorbed. The richness of whey in salts may be of more importance, for it is not impossible that under certain circumstances an excess of these may be beneficial. At present, however, it is not possible to give a satisfactory explanation of the *modus operandi* of whey cures, since a number of factors besides the mere consumption of a certain quantity of water, milk sugar, and salts have to be taken into account.

APPENDIX.

ON KOUMISS CURES.

By Dr. Stange,

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Although several allusions occur in the writings of Herodotus to the preparation of koumiss by the Scythians, and it must consequently have been known from the earliest times, it is only within the last forty years that this drink has been examined scientifically, and many questions still await solution.[1] This will be the less surprising when one reflects that in the Steppes, far removed from all scientific appliances, even the simplest examination is beset by almost insuperable difficulties, and we have not at present a single exact analysis of the koumiss of the Steppes. Seeland was the first to analyse mare's milk in the Steppes, and he found a somewhat larger proportion of casein than Biel and Stahlberg, who examined the milk of Steppe mares in St. Petersburg and Moscow, give in their analyses. One cannot, however, attach much importance to this circumstance, since Seeland has neglected to describe the method of analysis he followed.

Under circumstances of such difficulty we need not wonder that the influence exerted by koumiss on metabolism in the organism is still unknown. The enquiries so carefully conducted by Boikoff on the metabolism during a koumiss diet are not conclusive, since they were pursued during the winter in St. Petersburg with a koumiss prepared from the milk of mares under conditions of climate and food totally different from those of the Steppes.

Although we are not in a position to prove directly by figures the gain of the organism in albumen and fat during the employment of koumiss, nor to make any precise statements as to the changes in

[1] For full historical notices see Karrik.

arterial tension, it must not be hastily assumed that koumiss belongs to the class of untried remedies.

Koumiss claims a foremost place among those articles of food with which unfortunately physicians interest themselves less than they do with drugs, and a mass of unimpeachable experience and observation ascribes to it a special value in chronic diseases of the respiratory organs. Throughout the entire literature of koumiss it is maintained by all observers that startling results follow its use in the treatment of phthisis and chronic diseases attended by exhaustion and wasting. Those only who have never been in the Steppes and who judge of koumiss merely from books or theoretical standpoints view these successes with scepticism. Already physicians who have instituted experiments with koumiss in St. Petersburg and Moscow express themselves more favourably. Finally, the experience of the Steppes presents the most surprising facts as to the cure of phthisis and other diseases.

In the following general review of the Russian literature on the subject of koumiss all questions in which different observers have interested themselves will be touched on with the utmost brevity. At the same time I shall mention what authors have treated this or that question more exhaustively, and I shall go more closely into disputed points. In the special review of the labours of individual authors I shall refer briefly to all works which are not mere reproductions of others. Besides the sixteen treatises that I shall discuss there are in Russian literature numerous articles in periodicals and a number of compilations which I shall pass over as presenting nothing new.

Koumiss is the fermented milk of the Steppe mares, which serves as a food and an intoxicating drink for all the nomadic peoples of the south-eastern Steppe country of Russia. The quality of the milk as well as of the koumiss made from it depends greatly on the various conditions of country and climate, and of the food and the breed of the animals. Nearly all authorities are agreed that the best koumiss and the best results of the koumiss treatment can be had only in the Steppes themselves, although they admit that koumiss made in other districts, as in Moscow and even in St. Petersburg, from the milk of Steppe mares driven thither may be of use. Stahlberg is a solitary exception to this general statement, since he attributes the greatest importance to the breed of the mares and calls in question the influence of food on the quality of the milk.[1] Karrik has published a

[1] The polemic maintained on this point between Stahlberg and Postnikoff partakes unfortunately of a personal character, Stahlberg having a koumiss cure establishment at Moscow and appearing as a rival of Postnikoff, whose institute is at Ssamara. Impartial judges give the preference to the koumiss cure in the Steppes.

fairly exhaustive description of the flora of the Steppes, and its general character consists in the predominance of dry grasses rich in saccharine matter. The breed of milk-yielding mares is the product of artificial selection through the course of many centuries and possesses special features—viz. a large udder, secreting abundance of milk of a somewhat anomalous chemical composition.[1] Most authors believe the climate of the Steppes to be a very healthy one, but some hold an opposite opinion. The probable explanation of these discordant views is that its advocates speak of the summer months, which present a very hot, dry climate with but slight diurnal variation of temperature; while the opponents of the Steppes, among whom we again find Stahlberg, insist on the great annual variations and the low mean temperature of the year, due to the extreme severity of the winter's cold. The numerous and admirable observations of Ukke at Ssamara have so far solved the question as to leave no doubt that the summer climate of that place is most favourable for the treatment of chest complaints.

The preparation of koumiss demands both knowledge and experience, and is best done by the nomads, who now conduct the operation in all koumiss establishments; for the attempts to get it made by Russians have in most instances proved failures. The essential point is the most scrupulous cleanliness; the milk must be beaten up sufficiently, with a proper quantity of the ferment, &c. An exhaustive description of the different ways of preparing koumiss with artificial and natural ferments, as well as its preparation from cow's milk, is to be found in the splendid work of Poloubensky, which was published in 1865 and is still one of the very best treatises on the subject.

An exact insight into the chemical processes which take place in the preparation of koumiss will be found in Stahlberg, although others before him had conceived of them correctly when they defined koumiss as mare's milk undergoing at one and the same time acid and alcoholic fermentation, the latter process being encouraged by all possible means. From a chemical point of view koumiss presents a drink the composition of which is constantly changing, as the latest observations of Biel well show.

As to the physiological action of koumiss we find but few opinions expressed by early writers. The ease with which very large quantities can be taken has, however, caused surprise to all. Those who have watched the action of koumiss during a hot, dry summer

[1] An exhaustive account of the breeds and analyses of the milk of each will be found in the work of Stahlberg.

speak of its diaphoretic virtues, while those who have done so in a cold and rainy season consider it diuretic. Closer observations of its physiological action are to be found in Poloubensky, Postnikoff, Boikoff, and Karrik. The interesting and very careful labours of Boikoff were carried out unfortunately at St. Petersburg during the winter; but even under these unfavourable surroundings his results are highly interesting. He ascertained during the administration of koumiss a small but daily increasing retention of nitrogen in the organism. On the other hand with a diet of cow's milk the retention of nitrogen was at first greater, but it rapidly fell off on each successive day. Boikoff's experiments gave an increase of body weight, easy digestion of large quantities of koumiss, increased secretion of urea, acceleration of the heart's action, &c. It is obvious that in his laboratory Boikoff could form no adequate conception of the therapeutic value of koumiss, and his notions on this subject are marked by a certain *naïveté* and in no sense founded on his otherwise admirable work.

The greater part of the literature of koumiss is devoted to its therapeutic action, and especially directed to the treatment of particular diseases, as consumption. Until the sixties of the present century pulmonary consumption was held to be incurable, so much so that although an improvement in individual symptoms had long been observed, men would rather assume an error in diagnosis than admit a case of recovery. In course of time incontrovertible instances of the cure of consumption have accumulated in ever-increasing numbers, so as to have brought about a revolution of opinion on this point.

Postnikoff describes, for example, the autopsy of a consumptive patient who had resided for four years in a koumiss establishment, and was completely restored within the first year, though he later became again affected. At the autopsy fresh cavities were found alongside the cicatrices of those that had healed.

Cases in which consumptives have had their lives prolonged for years are often recorded. In one of the latest works, viz. that of Karrik, are several well-authenticated cases of consumption in which either a complete cure was effected or the patients' lives were prolonged for decennia. The cases collected by this author present startling results, and his statistical statements place the koumiss cure very high. The observations of Karrik are, however, in so many ways at variance with the opinions of others that one must await further researches before forming a definite judgment.

This much, however, appears to be already established, that koumiss has cured many cases of consumption, or at least has lengthened life. But one must not forget that most of the cases of

recovery have been recorded by physicians who have practised in the Steppes of Orenburg or Ssamara, so that the influence of the country and climate on the pathological processes must be taken into account. Many authorities, and among them Karrik, are unanimous in recommending consumptives to avail themselves if possible of the koumiss cure in the Steppes, while other diseases may derive benefit from treatment in urban institutions.

In publications issued last year a great influence is ascribed to koumiss in chronic gastro-intestinal catarrh. I have myself in my work expressly pointed out the value of koumiss in these diseases, and have given several demonstrative histories of patients in support. Such had been already observed by Poloubensky, but seem to have subsequently fallen into oblivion.

Sambrschitsky has given reports of over twenty-five cases of typhoid in which he employed koumiss during the period of highest temperature.

Earlier writers used to give a rather large catalogue of conditions contra-indicating the use of koumiss; but in course of time not a few of these have disappeared, and at the present time there are but few forms of disease in which koumiss is denied. It is long since pregnancy was considered a contra-indication, and diseases of the kidneys have been treated successfully with koumiss. Only those of the heart and great vessels are still held to preclude the koumiss cure.

These questions—that is to say, the literature of the subject—have been fully discussed by Herzenstein.

It is in truth no matter for surprise that there should be but few contra-indications to a dietetic remedy, and the feeling of recent observers against the necessity of any special diet during the koumiss treatment is clearly expressed. The older the writer the more foods and drinks do we find forbidden by him, while later ones prescribe a particular diet only in reference to the state of the patient's digestive organs.

Formerly enormous quantities of koumiss—more even than ten litres a day—were ordered, but now there are few physicians who deem such doses reasonable and very few patients who can drink so much. Perhaps there is some truth in the suggestion of Herzenstein, who connects the tendency of physicians towards smaller doses (five litres) with the disappearance of the pasturages and herds of mares, which has made koumiss harder to obtain, but it is certain that one now rarely finds a patient who can take more than six to eight litres per day.

Spassky compared the milk of different animals, and remarks on the peculiar characters of mare's milk that it contains less fat and casein but more sugar than others. His statements as to koumiss are based on the evidence of Jarotsky, who described the various modes of preparation, characters and action of this drink. Jarotsky represents the manufacture of koumiss as being very simple. The fresh-drawn mare's milk is poured into recently smoked out leather bottles or skins, called sabas, and treated either with sour cow's milk or the residue of old koumiss which has been well dried and preserved. The skins filled with milk are kept in a warm place, the milk is frequently shaken, and in the course of three or four days the koumiss is finished. It is a nutritious spirituous drink with a slightly sour taste, of which two kinds are distinguished—one light and unfermented, having a gently laxative action, and another strong and old, which is more used. Want of cleanliness spoils the koumiss and sets up putrefactive changes. To avoid this our author recommends the use of an artificial ferment, which is prepared as follows :—

Two tablespoonfuls of wheaten flour are mixed with water, and two spoonfuls of millet, one of honey, and a little beer yeast are added. The mixture is stirred up with some mare's milk to the consistence of gruel and left to stand in a warm place. It soon turns sour and begins to ferment. It is then tied up in a small linen rag and put into the vessel in which the koumiss is to be made, and about five litres of fresh-drawn mare's milk slowly poured in with constant stirring. The milk then, if kept at a temperature of 86° to 90° F., is at the end of twenty-four hours in a state of fermentation, and forms an agreeable, acidulous, spirituous drink. It is then bottled, corked, and kept in a cool cellar till wanted. The same mass of ferment will serve for the preparation of several portions of koumiss.

The best koumiss is made in May, June, and July, from the milk of light-coloured mares which have not been put to work, and pastured in the Steppes not far from mountain ranges, where they can find flowing water and salt beds. It is also well if the mares can bathe frequently. They should not have hay or oats.

Spassky praises koumiss in diseases attended by emaciation and loss of strength, scrofulous abscesses, rickets, chlorosis, scurvy, atrophy in children, also in debility consequent on venereal excesses or onanism, and even in tabes dorsualis.

During the treatment the patient should be relieved of all anxiety, but should no less avoid exciting pleasures, and should lead a quiet country life, rise early, and take a glass of koumiss every half-hour. But during the two hours preceding the midday and the evening meals a pause should be made, in order to avoid spoiling the appetite for other food. The diet should consist mainly of meat and fatty

foods; sweets, fruits, and salads should be avoided. The patients should also abstain from the use of tea and coffee, and spirits should be taken only by those accustomed to them and in small doses. The diarrhœa which often accompanies the use of koumiss may be checked by lime water.[1]

According to an article by Homenko in the same journal there are two kinds of koumiss, one light and slightly fermented, the other strong and highly fermented.[2] The properties of koumiss are the following:—

Even in large doses it does not inconvenience the digestive organs and is well borne by invalids; the urine is increased by it and the bowels become regular. The stronger koumiss, if taken on an empty stomach, acts as a feeble intoxicant. The blood after a course of koumiss is richer in fibrin and hæmoglobin, and after two months' treatment the patients feel better, acquire a good complexion, and become stouter, especially those whose emaciation did not depend on any organic disease. Koumiss, being so nutritious and easily digested, soon effects a restoration of the tissues, and its advantage over all other dietetic remedies consists in the fact of its containing, over and above the ordinary nutritive materials, alcohol, which aids the digestion, carbonic acid gas, which relieves the irritability of the stomach, and salts acting mildly on the intestinal canal, so that koumiss is at once a food and a digestive. But it cannot be used in all cases—such, for example, as full-blooded subjects, who suffer from pressure of blood and incline towards apoplexy. In habitual constipation and in pregnancy also it is hurtful. On the other hand koumiss is especially useful in all chronic diseases of the lung with wasting, in scurvy, chlorosis, in many dropsical states, also in chronic mercurialism and in convalescence from typhoid fever. The most striking effects of koumiss are always seen in general exhaustion and impairment of nutrition.

The koumiss cure must be begun with a few glasses only of the koumiss, so as to accustom the digestive organs to it. The patient should afterwards during the summer months drink as much koumiss

[1] Spassky, 'On Milk in General and on Koumiss in Particular,' *Milit. Med. Journ.*, 1834 (Russian).

[2] Homenko, 'On the Curative Action of Koumiss in Certain Diseases,' *Milit. Med. Journ.*, 1842. The writer introduces his subject with a consideration of medicines in general, giving the preference to such as are most easily tolerated The mineral drugs are, he says, least so, the vegetable better, but the animal are best borne of all, and among these koumiss takes the first place. Thus koumiss ranks not with foods but with drugs. He ascribes to it his own recovery from a long and severe affection of the lungs with impaired digestion.

as possible, keeping to a meat diet and avoiding fruits, sweets, and spirits.

Daal [1] also describes koumiss as an important article of food and of medicine. To make it he states that the saby (leathern sack) is filled with mare's milk, to which the residue of some old koumiss is added, and frequently shaken. Among the nomadic races of the Steppes it is the custom for everyone who enters the tent to take up the skin and shake it several times. Mare's milk contains much sugar, but little casein and fat. The properties of koumiss, according to Daal, are a sweetish sour taste and a peculiar rough odour; it quenches thirst remarkably and imparts a feeling of high spirits; the appetite is not materially affected, although a sense of hunger is for the time appeased. The most remarkable fact is that while large quantities of koumiss are easily digested half the quantity of water or of any other drink would be felt inconvenient. The intoxicating action of koumiss is very slight and transient; it is essentially nutritious and blood-forming. It causes free perspiration, and the secretion of urine is therefore not so great as one would expect after so much fluid had been taken in. The fæces are in small bulk, and there is as a rule a tendency to constipation. Koumiss is drunk with ease, and as much as twelve litres daily may be taken without any inconvenence. Its curative effects are seen after the end of a few weeks; the patient feels himself fresher, his complexion improves, his breathing is deeper, &c. After a severe winter, which imposes great hardship and even actual starvation on the nomads, the rapidity with which, thanks to koumiss, they recover themselves is astonishing. This author doubts whether there is any other food capable of restoring lost strength so speedily. From these practical considerations he draws the following indications for its use: It is of special value in diseases where a diet rich but easily digested, and which taxes the digestive organs as little as possible, is indicated. It is not asserted that advanced consumption will be cured by koumiss, but this result is assuredly attained in cases of predisposition to phthisis, and even in the later stages the general state of nutrition improves conspicuously. In order that the koumiss may not disagree several other foods, as some sauces, all sweets, and coffee, should be prohibited; it is also better not to permit the use of wine. The best diet is that of the nomads—a piece of bread with roast mutton and salt, fifteen to twenty glasses of koumiss drunk daily—and the patient should live in a tent (*kibitka*) and walk well. Hunger and

[1] Daal, 'Concerning Koumiss,' *Journ. of the Ministry of the Interior* (Russian), vol. i. 1843.

habit usually overcome the repugnance to the not over clean preparation of the koumiss by the nomads.

The koumiss and the air of the Steppes is preferable to the use of koumiss elsewhere.

An article by Waradinoff,[1] who was not a medical man, has no great weight in koumiss literature, although it is frequently quoted; but as a sensible man and a keen observer he understood and judged correctly in many things.

Waradinoff laments the entire absence of exact knowledge on the subject of koumiss, and that no one knows where he can even get the genuine thing. If one go, he says, to the Steppes on purpose, one probably falls into the hands of adventurers, who charge exorbitantly for bad koumiss and badly cooked mutton. He then describes the ordinary mode of preparing koumiss in the Steppes, and also that followed at the then solitary koumiss institute of Postnikoff, who paid considerable attention to the whole question of the koumiss cure, and opened an establishment in the neighbourhood of Ssamara, where comfortable quarters, good koumiss, and good fare are to be had. There Waradinoff underwent a course of treatment and remarked the beneficial effects both on himself and others. As to the therapeutic action of koumiss, Waradinoff as a layman refers to the above-quoted passages from Daal. For his own part he adds that he cannot conceive why a special diet should be enjoined with the koumiss cure, and advises others to do as he did—i.e. to drink as much koumiss as they can without over-filling the stomach, to increase the quantity gradually, but in other respects to follow no particular diet.

Seeland collected his observations made in the province of Orenburg during a residence of two years,[2] and to him we owe the only analyses of mare's milk which have been carried out in the Steppes; he does not, however, give any information as to the methods employed. With respect to its component parts mare's milk most nearly resembles woman's milk. It is thin and sweet. Its specific gravity varies between 1,018 and 1,029 [3] when the mare is fed on grass and milked four to six times a day. The average numbers from the analyses are shown in the following table :—

In 1,000 parts—

Water	914·18
Sugar	36·20 (in hot weather to 70·2)
Fat	18·23 (in hot weather less)
Casein	29·35
Salts	2·22
Total solids . . .	85·82

[1] Waradinoff, *Journ. of the Min. of the Interior*, March 1859 (Russian).

[2] Seeland, 'On Koumiss,' *Modern Medicine*, 1861, 52, and 1862 (Russian).

[3] These results are probably owing to the use of an incorrect areometer.—Dr. Stange.

The casein of mare's milk gives only a light sediment in the vessels. Koumiss is mare's milk that has undergone simultaneously lactic and alcoholic fermentation. The latter is set up by the addition of a ferment and the action of a high temperature with frequent mechanical movement of the liquid. A part of the milk sugar is converted into lactic acid and part into grape sugar, which is afterwards broken up into alcohol and carbonic acid. The shaking favours the alcoholic fermentation and ensures a proper mixture and comminution of the undissolved constituents.

The mode of making it differs, according to Seeland, in different tribes. Usually a narrow-necked leathern sack is taken, filled with the milk and some of the ferment, which is either old koumiss or simple sour milk; they are stirred with a stick. The sack is put to stand in a warm place and carefully shaken. For making good koumiss the utmost cleanliness is necessary: it must also be carefully mixed and not diluted with water or the milk of other animals. The vessels used may be of wood or glazed ware. The quantity of the ferment and the temperature have a great influence on the quality of the koumiss; its fitness for use is determined by the taste, by which also one judges whether enough ferment has been introduced and whether any change of temperature is desirable. Good koumiss has a very agreeable, slightly acid taste, and while being drunk the carbonic acid gas rises into the nose. In appearance it presents a homogeneous, milky, foaming liquid containing about 1 per cent. of alcohol and lactic acid. Introduced into the stomach it causes an eructation of carbonic acid, lasting for a longer or shorter time. Fresh koumiss induces more or less rolling in the bowels and often diarrhœa; old koumiss gives a feeling of burning at the epigastrium, and frequently leads to constipation, but that of medium age may be drunk without the least inconvenience. Seeland drank easily ten bottles daily. Meanwhile the appetite is not lost, though light food only should be taken, no other drink than koumiss, and no sweets, since these are apt to spoil the appetite. Seeland explains the easy digestion of koumiss by the small quantity of alcohol present, which stimulates the secretion of the digestive juices, as well as of carbonic acid, which diminishes the irritability of the stomach. During a course of koumiss in hot weather there is a copious perspiration, while proportionately less urine is secreted; in cooler weather the renal secretion increases, as the cutaneous is less.

When the temperature was 20° C. (68 °F.) Seeland drank daily about 6 litres of koumiss and ½ litre of tea, ate about one kilogramme of meat, walked 6 to 8 English miles, and slept 8 hours. At the same time he secreted 3,200 to 3,800 cubic centimetres of urine with a sp. gr. of 1,010 to 1,011. While he usually

passed 50 grammes of solids in the urine the daily excretion during the koumiss cure was 60 grammes.

From the increase of the urinary solids during the koumiss cure Seeland assumes an increase in metabolism. At the same time the body gains rapidly in weight, for, notwithstanding the watery character of the koumiss, the quantity of solid constituents taken is very great. It never intoxicates, the proportion of alcohol being too small, but it often produces a tendency to sleep, mental languor, and aversion to work. Seeland remarked a strong excitement of the sexual organs, which he attributed to the alcohol, animal diet, and heat of the air. The chief peculiarity of koumiss is its easy digestibility, and on this rest the various indications for its use. It is especially valuable where a food is wanted rich but light, and one which shall produce its results as speedily as possible, as in scurvy, anæmia, chlorosis, marasmus, convalescence from typhoid, and tuberculosis.

Seeland was ordered to a Bashkir village with twelve invalid soldiers for koumiss treatment; nine of them were in one or other stage of phthisis. Nearly all showed symptoms of destruction of lung tissue—namely, dulness at the apices, bronchial breathing, sonorous or even cavernous râles, tympanitic resonance in circumscribed places, &c. The whole of the patients became stouter, ceased to cough and slept; the evening rise of temperature subsided and the appetite returned. The objective changes remained generally unaltered, except that the râles became less numerous and loud.

Such results, achieved in the course of three months, Seeland considered as most encouraging, since he held consumption to be incurable. He was quite contented with an improvement of the general condition and the disappearance of the harassing cough, the sleeplessness, and the fever.

Seeland does not believe in any specific action of the Steppe koumiss, which cannot be endowed with a special healing power, originating solely in the Steppes. Even as regards the *Pfriemen* (awl grass) it is far from growing everywhere where koumiss is made. He lays greatest weight on the mares themselves, and differs from Postnikoff in his opinion of the climate of Ssamara, showing that, on account of the frequent fluctuations of temperature—severe frost and winds in winter and dry heat in summer—it is not nearly so tolerable as Postnikoff asserts.

Radakoff, who was formerly of opinion that a koumiss cure could be successfully carried out only in the Steppes, came to the conviction that such was not the case after having passed the summer at Ssamara in very bad weather and a wretched cottage.[1] The treatment at Ssamara, how-

[1] Radakoff, 'On the Possibility of Koumiss Cure in Moscow' *Modern Journ. Médecine*, 1868, No. 36 (Russian).

ever, gives excellent results, since not a few cases are completely cured, while in others a considerable improvement is obtained; but this is only in the earlier stages. If large cavities have formed, or high fever or hæmoptysis be present, the koumiss cure but hastens the progress of the disease. Although Radakoff ascribes a certain value to the forage of the Steppes and the race of mares, he believes that these mares, if brought to Moscow, would continue to yield milk of the same character. The question of the practicability of preparing koumiss in Moscow seems to have been settled by Stahlberg, who obtains very good results in his koumiss establishment in that city.

Feeling that the treatment of typhoid diseases consists essentially in nutrition and stimulation, Sambrschitsky determined to try the effect of koumiss in an apparently hopeless case. The patient was at the twelfth day of the disease in high fever and unconscious; the stools were liquid and offensive, the features sunken, pulse threadlike and very frequent, and muscular twitchings and decubitus completed the picture. The patient now received at short intervals spoonfuls of koumiss, and as soon as the following day a reaction could be perceived. He rapidly improved from this time, and, encouraged by this happy result, Sambrschitsky treated several other cases with koumiss, all of which recovered.[1]

According to Bogojawlensky,[2] koumiss is a spirituous and highly nutritious drink used by nearly all the nomad races of the southern Steppes. Mare's milk, from the relatively large proportion of sugar it contains, is the only kind available for its preparation. The Steppe mares give, especially during the spring, abundance of milk, from which the women make koumiss until the approach of winter. Those mares are considered the best which have foaled in March or April and are of middle age. They are milked from four to eight times a day, according as the foals have had access to them just previously or not. Each milch mare yields about six champagne bottles. Mare's milk, like mother's milk, is thin, sweet, and foams with ease. In spring and autumn the milk is thicker, but in summer, when the grass is dried up, it becomes thinner. It turns sour sooner than that of other animals, and when drunk is apt to cause diarrhœa. For its preparation either leathern sacks with a stirring-rod or narrow-necked tubs of lime wood are used.

The different kinds of koumiss have different tastes; the weak

[1] Sambrschitsky, 'On the Curative Effects of Koumiss in Typhoid Fever,' *Modern Medicine*, 1861, No. 31 (Russian).

[2] Bogojawlensky, *Complete Practical Handbook of the Manufacture of Koumiss and its Employment as a Medicinal Drink* (Russian). Ssamara, 1863.

one-day koumiss is agreeably acid, gives no sediment, and corked in bottles effervesces. Each day the koumiss becomes stronger, its taste sharper, and the smell less agreeable. Such koumiss contains much acetic acid, but corked in bottles it remains longer undecomposed. The course of the fermentation is arrested if it be heated above 95° F. or cooled below 45° F., but it then undergoes rapid putrefaction. In hot weather the vessels are placed in ice or buried in the ground. Weak koumiss bottled and corked and kept at a temperature of 68° F. to 82° F. becomes of medium strength on the second day and of full strength on the third; sudden change of temperature spoils it. The Bashkirs drink enormous quantities of strong koumiss for the purpose of intoxication; and they do not waste the spoilt koumiss, but drink it mixed with milk or water. Koumiss is often watered to cheat the buyer, though water should never be added to good koumiss. For many patients with chest diseases a journey to the south should follow the koumiss treatment. Mare's milk as such frequently gives good results, provided always it does not cause diarrhœa.

Koumiss strengthens the system and stimulates in several ways; patients who from weakness and asthma were unable to walk take long walks after a fortnight's treatment. Great quantities of koumiss lead to no inconveniences whatever; they cause no pains in the epigastrium, the appetite improves, the bowels become more regular; the fæces are but slightly coloured, of firm consistence, and without odour. Koumiss induces free perspiration and abundant diuresis, any tendency to urinary deposit disappearing. Cough and dyspnœa cease or become less, the expectoration is more liquid and transparent. Sometimes slight intoxication is observed, followed by flushing of the face and giddiness or prolonged sleep. Morbid secretions from the mucous membranes disappear, some wounds, especially scrofulous abscesses, heal rapidly, the patient becomes stouter and acquires a fresh complexion and good spirits, the body weight and strength increase. The effect of the diet as well as the air of the Steppes must be taken into account. The treatment in the Steppes lasts two or three months, and is often renewed in the following summer. The koumiss is richer in autumn, but the spring is the healthier season on the Steppes.

Koumiss can be made everywhere. There is a proverb among the Bashkirs, 'Eat mutton and drink koumiss, and you will always be well,' but the koumiss must be good. Bogojawlensky considers a previous course of mare's milk to be needless, and advises beginning at once with koumiss. At first two or three bottles of weak koumiss should be drunk daily, and the doses and strength gradually increased

until at the end of two weeks six to ten bottles a day have been reached. Some persons go as far as fifteen bottles daily by the third week, but such cases are rare; usually, however, five to eight bottles are drunk every day. Those who begin at once with large doses soon feel a repugnance to it, and are compelled to reduce them. But of really good koumiss one can take enormous quantities, especially if the weather be warm, walking exercise taken frequently, and other foods and drinks restricted. Warm koumiss is easier drunk than cold, and it is best given at a temperature of 82° to 95° F. In the early morning the patient tries to drink as much as he possibly can, leaving off a couple of hours before breakfast; a similar pause is made before the noonday and evening meals.

The occurrence of constipation calls for no special treatment; diarrhœa, on the contrary, is very weakening, and must be promptly checked either by a change in the kind of koumiss, or by warming the drink, or, in more obstinate cases, by suspending the koumiss cure for a few days. Should the diarrhœa be owing to some error in diet, as the use of fruits, sweets, or cow's milk, the diet must be strictly regulated. Diarrhœa may be a consequence of want of cleanliness in the vessels, inducing early putrescent changes in the koumiss. Obstinate constipation that has lasted three to five days may be relieved by the use of mare's milk, a bottle of which, fresh drawn, and taken on an empty stomach, invariably produces two or three liquid stools. The slight intoxication which the strong koumiss of the autumn months often produces passes off after a short walk or sleep. If a sense of pressure in the head or strong palpitation be felt, the patient must for a time resort to the milder form, and allow the carbonic acid to escape by pouring the koumiss into a basin and leaving it to stand for a few minutes before drinking it. Hæmorrhoidal and menstrual hæmorrhages call for an interruption of the treatment only when the loss of blood is considerable.

The occurrence of bleeding from the nose is also in part due to the heat. In hæmoptysis one must be extremely cautious in the use of koumiss, substituting mare's milk for it at first and then very gradually passing over to the milder kind of koumiss, the carbonic acid having been allowed to escape, and lastly not giving even this in large doses. In dysentery koumiss is inadmissible until all diarrhœa has ceased, when small quantities warmed to 95° F. may be prescribed. Strong koumiss occasionally induces sleeplessness and hysterical attacks, which may be avoided by taking the weaker kinds only, and discontinuing these some time before retiring to rest.

Koumiss is very effective in anæmia and the symptoms dependent

thereon, in exhaustion from frequent child-bearing or excessive mental strain, in defective nutrition, in debility following venereal abuse or onanism, in scurvy and mercurialism, and material improvement is to be obtained in phthisis. It is injurious in plethora, in chronic hæmorrhages during pregnancy, in constipation, gout, and diseases of the kidney and bladder. The koumiss cure is, in fact, essentially nothing more than a high nutrition of the sick.[1]

The diet must be moderate, of meat, game, fish, and boiled vegetables; all indigestible foods, smoked or fat meats, must be avoided; tea and coffee, too, are forbidden. No drugs should be taken during the koumiss course, though external remedies may, of course, be used if necessary. During febrile conditions the koumiss must be discontinued.[2]

Poloubensky ascribes the introduction of koumiss into therapeutics[3] to observation of the habits of the nomad races, who throw off the many ailments contracted during the cold and hardships of winter so soon as, with the appearance of the fresh grass in the spring, their mares again yield abundance of milk, from which koumiss is prepared.

Poloubensky describes exhaustively the different ways of manufacturing koumiss. It is prepared in leathern sacks, in earthen vessels, or in wooden churns, these last being about a metre high, and 15 centimetres wide at the base. In the lid is a hole through which passes a rod, carrying at its other end a perforated disc. The leathern vessel is made of a smoke-dried horse hide sewn together so as to make a narrow-necked flagon, and is provided with a stirring-rod. These leathern flagons are from time to time smoked afresh. The earthen vessels are simple narrow-necked jars. Into any of these various vessels the ferment is first introduced, consisting usually of old koumiss or its sediment carefully dried; of this about 200 grammes is mixed with 2½ litres of fresh milk. When neither koumiss nor its dried sediment

[1] The overwhelming majority of the patients who resort to Ssamara are phthisical, and though the experience of the physicians there is, that no complete cure is achieved, yet in many cases the treatment gives great relief and arrests the further progress of the disease; a result towards which the climate of the Steppes contributes much.

[2] This author is of opinion that the koumiss cure can be followed out as well with the Bashkirs on the Steppes as in a first-class establishment. To the question 'Where is it better?' he answers, 'Where we are not;' for man is at all times and in all places dissatisfied. The topographical facts given in this *brochure* have no further interest; Bashkir villages are named, where one can get koumiss and mutton cheap, and so on. At that time the only establishments open were those of Postnikoff and Annaeff.

[3] A. Poloubensky, 'On Koumiss,' *Med. Journ. of the Ministry of War*, 1865 (Russian).

is to be obtained, recourse is had to an artificial ferment. To make this 200 grammes of beer yeast, 100 grammes of wheaten flour, and a spoonful of honey are mixed in a glass of milk to the consistence of dough. When it has begun to rise it is wrapped in a cloth and put into a vessel containing $2\frac{1}{2}$ litres of mare's milk. Common sour milk may also serve as a ferment. The alcoholic fermentation is favoured by several means, above all by frequent stirring. By this means one secures a uniform distribution of the solid materials] and hastens the alcoholic fermentation without exercising any appreciable influence on the lactic. Poloubensky explains the action of the stirring by supposing that the milk sugar must for its conversion into alcohol be brought as much as possible into contact with oxygen. The temperature for koumiss-making should be somewhere between 55° and 95° F. Want of cleanliness leads to putrefactive changes and butyric fermentation. When the vessel and the ferment have been got ready, one part of the ferment is poured into ten of fresh-drawn mare's milk, and briskly stirred during the whole day, though allowed to rest at night. If it is desired to have koumiss of different strengths, three vessels are taken, and the first is filled with milk and ferment as above described. Next day its contents consisting of weak one-day koumiss are poured into the second vessel, all but a tenth, which is left to act as a ferment to the fresh milk with which the vessel is again filled. One has thus at the end of another day weak one-day koumiss in the first and koumiss of medium strength (two days) in the second. Proceeding thus one obtains by the end of the third day [i.e. morning of the fourth] all three kinds. To start the second course the residue of the third vessel is taken; thus one can have koumiss of all degrees of strength ready at all times. Strong koumiss can be made in another way: medium koumiss is put into a bottle, firmly corked, and allowed to stand in a warm, light room for twenty-four hours; fermentation goes on in the bottle, and one gets koumiss of the desired strength. Although the preparation appears so simple, it requires considerable practical knowledge. It is of great importance to suit the strength of the ferment to the volume of milk, to regulate the fermentative process, and either to hasten it by warmth and stirring or to moderate it by cold, if a really good koumiss is to be secured.

Of other milks which may be used for koumiss ass's takes the first place on account of its saccharine character; cow's milk is less suited. From the latter Poloubensky made koumiss in the following manner:—Into a clean oaken cask he poured a bottle of five-day-old koumiss to serve as a ferment, adding thereto a glass of warm water (77° to 88° F.) in which 13 grammes of ordinary, or still better of milk, sugar had been dissolved, and then a bottle of skimmed cow's milk. The skimming and the addition of sugar served to bring the composition of the milk nearer to that of the mare. The mixture was beaten for half an hour at the temperature of the room, and left to stand for three hours, when another bottle of skimmed milk was added, and the beating resumed for half an hour, till the mixture was uniform and bubbles of gas began to form on the surface. One more bottle of skimmed milk was added, and the beating repeated. At the end of 48 hours the koumiss was ready. It was then put up in well-corked or stoppered bottles, and kept for two or three

days, according to the strength desired. Cow's-milk koumiss is not usable after four days except as a fermenting agent. The same practical knowledge and experience are required for making koumiss from cow's milk as from mare's. If no stale koumiss be at hand, the artificial ferment already mentioned may be used, but in that case the beating must be performed as long again as in the usual process. Poloubensky advised the use of koumiss from cow's milk especially in large towns, and for poorer persons who have not the means for undertaking so long a journey. Artificial koumiss is much more digestible than fresh cow's milk, and koumiss from mare's milk is good only in summer; in winter it is very hard to get, since the mares then yield little or no milk. Observations on six patients convinced Poloubensky that the koumiss made from cow's milk was much better digested than was the original milk, and that its action on the nutritive processes was the same as that of mare's-milk koumiss.

As regards its physical characters koumiss presents a homogeneous milky fluid of a sweetish-sour taste; brisk hissing and foaming follow the opening of the bottle—indeed, the tension of the gas is such that the bottles not unfrequently burst. The smell of koumiss is harsh and characteristic, not only of the animal, but of the plants on which it has grazed. The taste alters with the age of the koumiss; cleanliness in its preparation is of scarcely less influence; and frequent bathing of the mares has been recommended as likely to improve the flavour of the drink—even in the same part of the country the koumiss does not everywhere taste alike. Most injurious are want of cleanliness in its preparation and the addition of water. The best koumiss is made in the governments of Ssamara and Orenburg. That prepared by Annaeff in the establishment at Ssamara was, as Poloubensky ascertained from personal observation, pure and free from water. The koumiss of Postnikoff presented several peculiarities, for since he has prepared it himself it is no longer bottled, but always made in open earthen vessels.

Poloubensky complains of the great discrepancies among the published analyses of mare's milk. His own gave such differing values that he has refrained from referring to them. He merely remarks that the chemical composition varies with temperature, time of milking, the season, and many other, some of them individual, conditions.

Poloubensky observed the effect of koumiss in several diseases, and believes that he can recognise a constant influence on the functions of certain organs. After taking two or three glasses he remarked in his own person a sensation of warmth in the region of the stomach, and when engaged in active bodily exercise two or three bottles caused no inconvenience, though an equal quantity of water would have been hard to bear. This character he explains by the action of the alcohol and lactic acid on absorption. Nausea never follows, and an interval of two hours is sufficient to enable one again to

swallow two bottles, after which a sensation of warmth in the stomach, eructation of CO_2, and a certain lassitude come on, lasting some time. Such a quantity of koumiss as that just mentioned does not in the least interfere with the usual enjoyment of breakfast and dinner. Persons used to koumiss will drink as many as fifteen bottles a day. After a week's course of koumiss the tongue becomes cleaner. If the koumiss be of the weak kind two or three liquid stools daily are the rule, and in persons prone to piles bleeding comes on. The laxative effects of weak koumiss soon pass off, and strong koumiss causes constipation from the first; so that, as a rule, an evacuation occurs only once in three days. The fæces are solid, almost odourless, slightly coloured, and small in amount in consequence of the completeness of absorption. Too large doses or a too long-continued use of koumiss lead to diarrhœa and abdominal pains. Very nervous persons cannot take koumiss on an empty stomach. Poloubensky believes that the soluble constituents are at once absorbed in the stomach; the fat and albumen are, after a very short contact with the digestive juices, rapidly absorbed in the bowel, and with scarcely any residue. After their passage into the blood the ingredients of the koumiss excite the heart's action and produce an overfilling of the vessels, the pulse rises to the extent of fifteen to twenty beats in the minute, and, although this acceleration abates somewhat later, the pulse remains during the whole of the cure more rapid and fuller than before. Persons of excitable temperament, with a tendency to palpitation, feel themselves worse at the beginning of the course. Pressure of blood to the head is frequently observed, with redness of the face. Congestions of affected organs are of frequent occurrence; a fact which must be kept in mind in the treatment of tuberculous patients, since in such cases the tension of the vessels in the lungs may excite hæmoptysis, when one must either suspend the treatment or give the koumiss in smaller doses. Sometimes hæmoptysis would seem to follow the increase in the volume of the blood, but this does not occur until after several weeks. The breathing, too, becomes quicker, which Poloubensky explains by the increased mass of blood, and consequent demand for oxygen on the one hand, and the diminished capacity of the thorax through the upward pressure of the diaphragm by the overfilled stomach on the other. The cough changes from dry to loose, the thick, tough sputa into a fluid, frothy mass easily expectorated. In some observations made on himself Poloubensky found that the secretion of urine was the same as after drinking like volumes of simple water or tea, but that there was not that lowering

of the specific gravity which followed invariably on an increased imbibition of water.

Thus, for example, under ordinary circumstances he excreted 1,500 cubic centimetres of urine with 60 grammes of solids. When taking a large quantity of water the urine rose to 2,400 cubic centimetres with the same 60 grammes of solids; whereas when he had drunk six bottles of koumiss the quantity of solids rose to 86 grammes, though in other respects his diet was the same as usual.

When large quantities of koumiss are being taken there is an increased desire to micturate, and if urethritis be present the secretion of the mucous membrane is increased. The perspiration is more copious, and the excessive secretion of the sebaceous glands produces a tendency to acne. But koumiss exerts its greatest influence on the general nutrition, and it has long been known to induce a surprising degree of stoutness in persons previously spare, and in some consumptives.

By measuring the circumference of the chest before and after the koumiss cure Poloubensky proved an increase in the course of two months at the level of the axillæ of 2 centimetres, at that of the ensiform process of $1\frac{1}{2}$ centimetres, in the circumference of the upper third of the thigh of 1 centimetre, and around the calf of $\frac{1}{2}$ centimetre.

Such an influence on the nutrition of the organism is explicable, according to Poloubensky, only by the improvement of the digestion and the complete utilisation of the koumiss. It acts also as an excitor of the genital organs, manifested by erections in men and by increased menstruation in women, the period coming on earlier and lasting longer than usual. Sometimes menstruation appears during the use of koumiss in women who had previously suffered from complete amenorrhœa. Small doses of koumiss have an exhilarating effect, imparting a cheerfulness to the spirits, while larger doses produce a feeling of drowsiness and sleep. The excitement of the nervous system manifests itself sometimes by sleeplessness, which, however, soon passes away after a few small doses of morphia. Other annoying symptoms occasionally observed—a creeping of the skin and the occurrence of urticaria—are also relieved by morphia. After a long course of treatment the patients, as a rule, experience a sensation of general comfort and a great disposition to sleep.

The daily doses of koumiss that Poloubensky saw given ranged from 2 to 9 litres. His therapeutic observations were collected during three years and referred to over 200 patients, of whom the greater number were consumptives. In diseases of the digestive organs koumiss is especially serviceable, presenting the foodstuffs in

forms easy of absorption, the lactic acid at the same time aiding digestion, the CO_2 allaying the irritability of the stomach, and the alcohol stimulating the secretion of the gastric juice.[1] Acute diseases of the stomach and bowels contra-indicate its employment.

Koumiss acts brilliantly in bronchial catarrhs, the dry cough and tenacious secretion vanish, expectoration becomes easy, and in this way pulmonary emphysema is benefited. In the later stages of phthisis it sometimes happens that the fatal termination is postponed, though further success is precluded by the fact that such patients are not well able to take much. The treatment is far more successful in the earlier stages of the disease, when there is no very extensive destruction of lung tissue, with moderate purulent expectoration and only occasional fever. In forty of such patients Poloubensky satisfied himself that there was, not merely an improvement of the general appearance, but also of the local processes—the catarrh abated and the fever disappeared. A further extension of the changes was arrested, and the period of quiescence was several times observed to last for three years or more. The most favourable results were obtained in patients in the earliest stages of the disease. A complete removal of the objective signs was not, it is true, achieved, but their general state of nutrition became very good. No results whatever followed when the patient either would not or could not drink more than one bottle of koumiss daily; a proof that the air of the Steppes was ineffective without the use of the koumiss. Koumiss, however, exerts no specific action on tuberculosis, and the success of the treatment culminates in the relief of the catarrh and the improvement of the general nutrition. The rich diet, furnishing nearly a kilogramme of solids in ten bottles of koumiss, prevents further loss of flesh and has a great influence on the progress of the morbid process in the lungs. Repeated hæmoptysis constitutes a contra-indication, although Poloubensky observed only five out of ten patients who had previously suffered from blood-spitting, in whom this symptom occurred after the treatment had been continued some time; and even in these it persisted only when increasing doses were being given, and ceased when appropriate measures were adopted.[2]

Poloubensky did not employ the koumiss treatment in diseases of

[1] The writer saw two cases of gastric catarrh, caused by abuse of alcohol and copaiva, rapidly cured by koumiss. Equally successful was the treatment in obstinate constipation following typhoid and dysentery. In both cases ulcers of the bowel were diagnosed which had previously resisted all possible remedies.

[2] Poloubensky observed the first occurrence of hæmoptysis during the koumiss cure in only two of thirty patients taking koumiss prepared in open

the liver or kidneys, believing on *à priori* grounds that it would be unsuitable. He often observed striking results in exhaustion after severe diseases, after child-bearing recurring in rapid succession, venereal abuse, and onanism, in which a variety of nervous accidents are not unfrequently present. It was equally successful in anæmia and chlorosis; and, indeed, in these cases the recovery is, in his opinion, to be attributed to the improved digestion.[1] In other dyscrasiæ, as scurvy, mercurialism, and chronic abscesses, koumiss effected a speedy cure. It was also successfully employed in chronic urethritis and leucorrhœa, when no organic changes existed in the uterus. Koumiss should not be used in nervous diseases marked by irritability, and is also contra-indicated in plethora, congestion of important organs, diseases of the heart and great vessels, and in pregnancy, since in the first half it tends to aggravate the vomiting and in the second to induce abortion.[2] Lastly in constipation, in diseases of the kidneys and urinary bladder, in organic diseases of the nervous system, and in acute febrile states it is inadmissible.

Poloubensky further discusses the question whether koumiss is to be looked on as a simple dietetic agent, or whether it has also a specific action, and comes to the conclusion that if a single bottle be drunk it is no more than a food, but that in the systematic use of five to ten bottles daily other effects come into play. Even the imbibition of large quantities of water accelerates metabolism and favours the elimination of waste products from the body. Koumiss aids on the one hand the elimination of effete matters, while on the other it furnishes abundant materials for the restoration of the tissues; so that it may be described as at once a resolvent and highly nutritious food. The phosphate of lime may be considered as having a specific action in tuberculosis and the lactic acid in scurvy.

The quantity of koumiss can never be prescribed exactly; one must always begin with small doses and gradually increase it in such a manner as not to overload the stomach or to excite repugnance. The usual practice is to commence with a single bottle and to rise to seven daily, but ten to fifteen are not unfrequently drunk. Those not accustomed to alcoholic drinks bear the mild koumiss best—and, indeed, it is advisable to begin with this in all cases. In constipation mare's milk should be substituted, and in diarrhœa the stronger

vessels. The dose should be increased very gradually, and from time to time a bottle of fresh mare's milk should be substituted for the koumiss.

[1] In one case of essential anæmia the use of koumiss was unsuccessful.

[2] The contra-indication drawn from pregnancy is, in Poloubensky's opinion, open to correction.

koumiss, to which in more obstinate cases rum may be added. Otherwise the use of alcoholic drinks, as well as of tea and coffee, is to be avoided. Further dietetic rules are unnecessary—indeed, the more varied the food the better.[1] After the course of treatment it is best not to return at once to one's usual employments, but to devote some further time to recovery and to take beer in place of koumiss, since otherwise the accession of flesh effected by the use of koumiss is soon lost. It is impossible to fix the duration of the treatment in the case of those patients who are most benefited by it; they should continue it as long as possible, and in winter, when mare's milk is hard to obtain, koumiss made from cow's milk may be substituted.

Koumiss presents certain differences in different years, and in spring it is less nutritious and less alcoholic, but more aromatic, the summer koumiss is often sour, while that made in the autumn is especially rich in nutritious matters and very strong. According to Poloubensky, the district is of no great importance, and the claims of that of Ssamara are unmerited; there are no plants characteristic of that part of the country, and the climatic conditions of the Crimea are far more favourable. The absence of tuberculosis among the inhabitants of the Steppes, which is often adduced as evidence of the favourable character of the climate, is not yet proved.

To the question whether patients should be sent to undergo the koumiss cure among the nomads or in well-conducted establishments Poloubensky replies in favour of the latter, since it is impracticable to send persons seriously ill to the Steppes, where nothing but rude tents, a little mutton, and rather questiona le koumiss can be had.

Stahlberg[2] deprecates the notion of physicians and laymen who believe that koumiss can be made only in the Steppes; for if so the cure would be available only for the wealthy classes. Stahlberg endeavours to correct this error, and disputes the influence of the Steppe grass on the composition of the mare's milk. Mare's milk

[1] Games, too, requiring bodily exercise, as billiards, are to be recommended.

[2] Dr. Stahlberg, *Der Kumyss und seine physiologische und therapeutische Wirkung*. St. Petersburg, 1869. In the introduction to his monograph on koumiss, occupying four sheets, the writer states that it was first introduced into medicine from the Steppes of South-eastern Russia, where its curative effects were observed first among the nomads and afterwards on patients sent thither. Physicians practising on the Steppes wrote many valuable articles, but these attracted little attention; and it was only after the appearance of Ukke's work in 1863 that people began to think about koumiss among ourselves and in Germany also. In France the first acquaintance with koumiss dates from the lecture read by this author on the subject before the Academy of Medicine in the year 1867.

differs from cow's milk in containing more sugar and less casein; a distinction which always and everywhere exists even if mares and cows are fed in the same pasture. The properties of the milks depend, therefore, on the animal, not on its food. Not in vain do graziers obtain from remote provinces animals yielding more and better milk than those of their own district; the change of food does cause these peculiarities to disappear, but the value of race is explicable from the standpoint of Darwin's theory. The mares of the Steppes, which have for ages served for milking only, and have never been subjected to labour, naturally yield a very different milk from that of the ordinary Russian horse; the food affects only the appearance and health of the animal. The Steppe mares, which are placed during the summer in very favourable circumstances, endure in winter terrible sufferings, for the grass has to be dug out from beneath the snow—indeed, their hunger is so great that many of them abort.

Stahlberg quotes also the observations of Boussingault, who found a quantitative difference only in the yield of milk by cows under different systems of feeding, the quantitative character of the milk remaining the same. The influence of race on the quality of the milk was proved by analysis of the milk of Steppe mares and of common Russian mares which had fed alike in the same meadow not far from Moscow. The analysis made by Gartié gave the following results:—

	Steppe Mares	Russian Mares
Water	89·20	89·58
Total solids	10·80	10·42
Fat	2·12	2·45
Milk sugar	7·26	5·95
Casein and salts . . .	1·42	2·02

The casein in the milk of the Steppe mares was present in a more easily soluble modification and precipitated with difficulty by acids. The fat of this milk was also less firm.

Stahlberg is of opinion that, with the help of Steppe mares, koumiss of identical quality could be made everywhere. Transported with the idea of the possibility of providing the koumiss cure for the inhabitants of great towns, he comes to the conclusion that the climate of Moscow has the advantage over that of Ssamara. He shows by figures that the difference between the highest and lowest temperatures during an entire month is less at Moscow, and maintains that the hot, dry climate of Ssamara must be injurious and debilitating to many patients. The opening of koumiss establishments at Moscow further renders it possible to make exact physiological observations on the action of koumiss.

After describing the recognised modes of manufacturing koumiss he explains that the chemical process consists in the conversion of milk sugar into glucose.

$$(C_6H_{10}O_5 + H_2O = C_6H_{12}O_6),$$

which next breaks up into alcohol and carbonic acid

$$(C_6H_{12}O_6 = 2\,C_2H_6O + 2\,CO_2).$$

It is obvious, however, that, though the products of these decompositions are present in koumiss, their quantity is but small compared with that of lactic acid. The analysis of two-day koumiss made in Moscow from the milk of Steppe mares gave the following values :—

	Per cent.
Alcohol	1·65
Fat	2·05
Milk sugar	2·20
Lactic acid	1·15
Finely divided casein	1·12
Salts	0·28
Carbonic acid	0·70

From this table it is evident that by no means the whole of the milk sugar was transformed after two days' fermentation. If such koumiss be bottled and corked the fermentation continues. Koumiss which had been kept for six months in the cold gave on analysis the following values:—

	Per cent.
Carbonic acid	1·86
Alcohol	3·23
Fat	1·01
Lactic acid	2·92
Casein and salts	1·21

In describing the physiological action of koumiss, Stahlberg repeats what has been already stated by other authors, since, for the most part, he draws directly from the work of Poloubensky. He confirms the digestibility of koumiss, the increase of appetite and of the urine excreted without any corresponding lowering of its specific gravity. From his own observations Stahlberg notices acceleration of the pulse and respiratory movements, and asserts that the vital capacity of the lungs constantly increases. The gain in flesh is the more striking the thinner the patient was before. On the sexual organs koumiss acts as a stimulant, and in small doses it excites the nervous centres, though larger doses lure to rest and sleep.

In the complex effects following the use of koumiss each of its several constituents plays a part. Thus the alcohol depresses the temperature, causes a disposition to sleep, and favours the storing up of fat in the body, the milk sugar sharing in the last-named result, while the lactic acid has a cooling effect and diminishes the frequency of the pulse. The casein replaces the waste of the organic tissues, but the carbonic acid increases the frequency and force of the heart's action. Koumiss has no special diaphoretic action. Stahlberg never observed such a result in Moscow, and at Ssamara it is doubtless dependent on the heat and dryness of the climate.

Among the diseases in which koumiss may be beneficial Stahlberg gives the first place to those in which the nutrition of the entire organism has to be improved; as anæmia, whether caused by great loss of blood, long confinement, continued suppuration, derangements of the digestion, abuse of mercury, &c.; also in chlorosis and scurvy, in hysteria, and in the adynamic period of acute diseases. Another class of diseases in which koumiss is very useful are those involving profuse secretion from the mucous membranes. In these koumiss sets up a determination of blood to the skin and kidneys and diminishes that to the mucous membranes. Thus it is that one must explain the curative effects of koumiss in bronchitis, vaginal catarrh, and catarrh of the stomach. In consequence of its action on bronchial catarrh koumiss is also of great use in phthisis.

Stahlberg quotes the opinions of numerous authorities on the cure of consumption, from which it would appear that koumiss is, beyond doubt, the best remedy we possess against that disease. It is of special value in those forms in which there is as yet little destruction of lung tissue and little fever. A case of pulmonary phthisis that had begun with copious hæmoptysis and showed cavities of the apices, diminished resonance on percussion, and bronchial breathing progressed very favourably under the use of koumiss. The temperature fell, the cough abated, strength returned, and the patient gained 9 kilogrammes in weight. At the same time the spirometer indicated a considerable increase in the vital capacity. The dull resonance, the bronchial breathing, and the symptoms of cavities at the apices of the lung all remained, though somewhat less marked.

If after two or three weeks of the koumiss treatment the patient does gain flesh this must be effected by some other means. In the author's establishment at Moscow fifty-two cases had been under treatment, with a mean gain of 3 kilogrammes in weight; females showing on an average a greater increase of weight than males, the means being respectively 3·8 and 2·2 kilogrammes.

The koumiss treatment is contra-indicated in diseases of the heart and great vessels; in diabetes it deserves to be tried, but Stahlberg has made no original observations. It is also contra-indicated in diseases of the nervous centres, the kidneys, urinary bladder, and liver.

Stahlberg compares the results of koumiss treatment in consumption with those that have been achieved by the use of cod-liver oil, or even through the southern climate of Madeira, and gives the preference to koumiss. The tendency to consumption, which often depends on accidental depressing causes, is most successfully combated with koumiss, since it so speedily restores the lost weight and strength. Diseases to be cured by koumiss must have a 'torpid' character. The best indications of the suitability of koumiss treatment in any case are the gain of weight and the effects on the temperature of the body. In the treatment of consumption koumiss takes the first

place, not in virtue of any specific action, but thanks to its nutritious character and power of lessening the secretion of the mucous membrane. The treatment itself is very simple; beginning with a single bottle, one mounts gradually to five or eight in a day. No particular course of diet is necessary; the desire for sleep must be satisfied; the enjoyment of pure fresh air and a life free from cares also play a great part in the success of the koumiss cure.

According to Postnikoff, who opened the first koumiss establishment in the year 1868, it is hazardous to undertake a course of koumiss without medical supervision, and, since the koumiss of the nomads is often worthless, patients are advised to submit themselves to the treatment only in a well-arranged institution under the conduct of a physician.[1]

Postnikoff, who makes mention of nearly every work on koumiss that had appeared up to 1869, expresses himself in terms of high approval of the treatises of Poloubensky and of Seeland, but attacks Stahlberg on the possibility of following out the koumiss treatment with success in other places than the Steppes. Postnikoff maintains that the pasturage of the Steppes has a great influence on the milk, and asks Stahlberg if Swiss cheese could be made from the milk of Swiss cows transported to the meadows round Moscow, or whether the vines of Champagne would yield the same wine in other soils and climates. He further demands proof that the breed of Steppe mares would remain unchanged if placed under strange conditions of climate and pasture. Lastly he asserts that the grasses of the Steppes contain a larger proportion of sugar than others.

Against the other opinion of Stahlberg, as to the advantages of the climate of Moscow and the dangers arising to consumptives from the hot, dry climate of Ssamara, Postnikoff maintains that this disease is only met with among those who are strangers to the place, and that, therefore, the climate of Ssamara cannot be bad; that moreover heat and drought are essential to the koumiss cure by exciting thirst, through which alone it becomes possible to drink such quantities. And as for the koumiss made by Stahlberg in Moscow, Postnikoff declares that it is worth just as little as are artificial imitations of mineral waters.

In Postnikoff's work one finds a fairly full treatment of the milk and of

[1] Dr. Postnikoff, *On Koumiss* (Russian). Ssamara, 1873. This author tells how the nomads of the Steppes, deriving many benefits from their herds, have by long experience and artificial selection produced a special breed of milch mares. The alcoholic strength of koumiss contributes not a little to its reputation. Both the mares and their owners endure great hardships and want during the winter, and become much emaciated; but in the spring, when the mares foal and find fresh grass, they give abundance of milk and fatten fast; their owners, enjoying the plentiful supply of milk, which they make into koumiss, improve in their appearance with extraordinary rapidity, and invalids who are sent to the Steppes do the same.

the influence of fodder on its constituents. He further insists on the importance of completely emptying the udders, since the first portion of the milk contains less fat than the last drawn. Mare's milk comes next to human milk in its composition; it has an alkaline reaction and its specific gravity varies between 1,035 and 1,045. After standing for 24 hours a thin layer of cream forms on the surface. Mare's milk curdles easily; it often acquires in summer a bitter taste, and becomes putrescent on prolonged standing; in contact with yeast it undergoes alcoholic fermentation. The curdled cream of mare's milk is very firm, but the butter very soft, reminding one of lard. Mare's milk turns so rapidly that the preparation of the koumiss must be begun not later than an hour after the milk has been drawn from the udder. Postnikoff believes that the difference between putrefactive changes and fermentations consists in the former being connected with the development of lower organisms, the latter with fungi, and that further the form of the fungi and the conditions under which they are developed determine the different kinds of fermentation.

Postnikoff gives the following directions for making a good koumiss, based on an experience of fifteen years:—

1. Mares used exclusively for milking, with large udders and long teats, should be selected. The milk must be thinner than cow's milk, of a sweet almond flavour and alkaline reaction.

2. The pasture must be near the milking place, that the mares may not be fatigued by long journeys, and should be rich in sweet grasses. Damp meadows are not good. Stipa pennata, strawberries, &c., are among the signs of a good pasture. There must be running water in the neighbourhood, which will serve not only for drink but for washing; it is also well to give the mares pieces of salt to lick. The foals are to be fed during the day, but left with their dams at night, for if they are taken away entirely the milk soon ceases to be secreted.

3. The best pails are those of oak; they should be kept scrupulously clean, and serve for keeping the milk and making the koumiss.

4. The mares are milked six to eight times a day, and give each time from half a bottle to a bottle of milk.

5. The best ferment is obtained from the sediment of old koumiss. This should be carefully dried and treated with alcohol to remove the fat, which is prone to become rancid. One gramme of such ferment mixed with a pound of mare's milk will, after standing 24 hours in a warm place, suffice to set up fermentation, and the matured koumiss will after the third day serve as a ferment for the next. If no dry sediment is to be had the artificial ferment may be prepared in the manner described by Poloubensky.

6. On to one part of ferment pour ten parts of milk: fermentation soon begins, and the formation of alcohol is favoured by frequent stirring and a temperature sufficiently high, viz. from 72° to 93° F. At the end of 24 hours the koumiss is put into bottles, in which the fermentation proceeds. Three sorts of koumiss are distinguished, according to the length of time that fermentation has been in progress. The weak koumiss is ready in six hours, in which so much CO_2 is developed that no bottle can stand the

pressure. At the end of two days the medium, and of three days the strong, koumiss is obtained.

The action of koumiss on the organism, Postnikoff characterises in three words—*nutrit, roborat, alterat.* Koumiss is a very agreeable drink, to which one soon becomes used; after drinking it one feels at once full, quiet, and cheerful, with a certain disinclination to mental work and a tendency to sleep. It induces a slight catarrh of the mucous membranes, which quickly passes off and can be best seen in the conjunctiva, which are reddened at the commencement of treatment. In mucous membranes already affected with catarrh there is at first a transient intensifying of the symptoms, which itself directly conduces to recovery in many cases. The most striking results of the koumiss cure are seen in diseases of the blood; and scurvy, as well as a number of other dyscrasiæ, is speedily cured. On the digestive organs it acts as a very digestible and light nutriment, which is slightly stimulating and thus aids digestion. Small doses, i.e. about a couple of bottles, increase the appetite; large doses satisfy and take away the desire for food. At the commencement there is generally constipation, but afterwards the bowels become regular. The quantity of urine is increased, especially in the cooler season, when the skin acts less; in hot weather the patients sweat profusely, and the perspiration has sometimes an odour of koumiss. These perspirations do not weaken the patient. The fat of the body increases and the figure becomes rounder and fuller. In diseases of the liver the secretion of the bile is lessened and bilious diarrhœa may be set up. Koumiss exerts an alterative action on the vascular system, the pulse becoming fuller and more frequent. The genital organs are strengthened and chronic gleets or leucorrhœa disappear. The first menstruation is either prevented or diminished by the koumiss cure, but subsequent periods are regular and copious. After a course of koumiss women previously barren frequently conceive. The first transient excitation of the nervous system soon gives place to a strong disposition to sleep.

In anæmic conditions koumiss is more active the less any actual lesions of internal organs exist; all the consecutive phenomena of anæmia, as hysterical and even epileptic attacks, impaired vision, dyspepsia, &c., disappear. Koumiss has the highest reputation both in the profession and among the laity in the treatment of phthisis. But unfortunately too many patients are sent to these establishments in the last stages, when they are no longer in a fit state to benefit by it.

Postnikoff distinguishes two forms of consumption, a chronic catarrhal

pneumonia and tuberculosis. In the former the secretion of the mucous membrane of the finer bronchi is drawn into the alveoli, where instead of being absorbed it is, in consequence of the weakness of the organism, converted into caseous masses. It is easy to understand how koumiss, by restoring the strength and thus leading to the absorption of the infiltration, may exert a favourable influence on this form of consumption. Even when the process has advanced as far as the formation of cavities, it may yet procure their cicatrisation or encystation. The development of tuberculosis, which often complicates caseous pneumonia, is prevented by the treatment, if this be undertaken in time. Bronchial catarrhs, which are often precursors of consumption, are easiest cured by koumiss. In florid galloping cases of consumption a cure is hardly to be expected, and also in chronic tuberculosis success is rare, probably because the intestinal canal is frequently involved, and in consequence of the pyrexia present at the same time absorption is materially hindered. In localised tuberculisation of the lungs the use of koumiss may probably arrest the further extension of the process.

For the cure of consumption it is not enough merely to drink koumiss; the patient must lead a rational course of life, breathe fresh and pure air, observe a regular diet, avoid chills, &c. As a rule the koumiss cure must be undertaken several times permanently to remove the chronic catarrhal pneumonia. The climate of Ssamara greatly assists in the cure by its mild and uniform character. Postnikoff has seen many instances of improvement or recovery in pulmonary diseases even without the use of koumiss.

The beneficial effects of koumiss in consumption show themselves by a diminution of the expectoration, which becomes more fluid and serous; the cough leaves off, the fever disappears, the exhausting night sweats cease, the general nutrition improves, and the patients assume a good complexion and recover appetite and sleep.[1]

[1] In support of his views Postnikoff adduces the history of a young man who was under his observation for five years, and of whom he at length obtained an autopsy. The patient came to his establishment with symptoms of chronic pneumonia, that appeared to have originated in a chill. At the commencement there was high fever, but by the end of the first season the temperature was normal and the patient felt himself well, although examination showed the presence of objective symptoms. In the following spring the patient returned to the institute with the same symptoms as at first, but in the course of two months his condition had improved to a still more striking extent. In three years new infiltration was detected in the lungs, fever was again present, the cough and dyspnœa were distressing. The patient had passed the winter under very unfavourable circumstances. All the above-named symptoms disappeared, however, during the koumiss cure. In the fourth year an improvement in his condition was once more attained by the treatment, but the cough and dyspnœa persisted, although in a less degree. In the fifth year the patient returned in a

Postnikoff further recommends the koumiss cure in diseases of the organs of digestion, as recognised by diarrhœa or constipation, pains in the bowels, derangement of the appetite, indigestion, &c. He also praises it in scrofula, vaginal catarrh, and chronic urethritis, venereal abuse, in convalescence after exhaustive diseases, in chronic skin affections, in ulcerations and caries. In all these diseases it acts as a nutritive agent and restores the organism to its normal condition.

When the organs of digestion are healthy, the results of the koumiss cure show themselves at once, in morbid states of these organs not until after some time. Koumiss is contra-indicated in high fever, in organic diseases of the brain, and renal or vesical calculus. To avoid sudden chilling of the body koumiss should be drunk warmed to about 77° F.; the absorption too is thus aided. Beginning with one bottle the daily allowance may be raised to 6 to 10. The larger proportion should be taken in the morning, and a pause should be made before dinner that the appetite may have time to recover itself. The koumiss should be gulped down in small doses at a time, active movement being kept up meanwhile. In constipation the weak form should be taken, in diarrhœa the strong. During the treatment the diet should be mainly of meat; liquids should be avoided, in order that so much more koumiss may be drunk; and spirits are actually hurtful. Vegetables may only be taken boiled.

The therapeutic effects of koumiss having been much more thoroughly examined by the greater number of authors than the physiological, Boikoff has endeavoured to supply this want.[1] The

pitiable state with continued fever and œdema of the extremities, and soon died. At the post-mortem examination the entire lungs were found converted into a cirrhotic tissue, and showing cheesy deposits in the middle lobes. In one lung the apex was cicatrised, the middle infiltrated, the lower œdematous.

From the evidence of this autopsy Postnikoff draws the conclusion that by the use of koumiss the catarrhal pneumonia was cured, as proved by the cicatrisation and encysting, but that under the unfavourable circumstances of the winters the process was again and again re-excited until it ultimately ended fatally.

[1] Boikoff, *Materials for Solving the Question of the Physiological Action of Koumiss* (Russian), Moscow dissert., 1876. The author states his opinion that the use of koumiss among all nomadic peoples is to be attributed to the fact that the conversion of the sugar by fermentation into alcohol, carbonic acid, and lactic acid gives it at once a nutritive and intoxicating action, whereas the unaltered mare's milk disorders the stomach and cannot be used as food. The palpably nutritive value of koumiss has also led to its being tried in diseases accompanied by exhaustion, especially in phthisis. All physicians who have watched the treatment of consumption by koumiss speak in the

majority of observations relate exclusively to the sick. At the same time the most prominent symptoms are brought under notice, and on these opinions differ widely.

Nearly all authorities agree that an improvement of nutrition and an increase of body weight have been observed not only after large doses of Steppe koumiss, but by the use of other and artificial kinds. All agree too that it has a slightly alterative and intoxicating action, which speedily passes into a feeling of restfulness and a desire for sleep. On the other hand the action of koumiss on the organs of digestion is very variously stated; all, however, agree as to its extraordinary digestibility, but some hold that it arrests the digestion of other food and strengthens the appetite. Most observers remark that weak koumiss is apt to purge, while the middling and strong tend to constipation. The increase of the urine secreted has been everywhere observed, but not so that of the specific gravity. The profuse sweating described by some is only met with in the dry heat of the Steppes. On the vascular system koumiss acts as a stimulant; the pulse is at first accelerated, but later becomes fuller and softer. Opinions, again, differ as to its action on the mucous membranes; most observers describe an increase in the quantity of the bronchial mucus, the secretion itself becoming thinner; only Stahlberg speaks of a lessening of the secretion and an unusual dryness of the membrane. Frequently an excitation of the genitals is spoken of. More exact observations as to the influence of koumiss on the temperature of the healthy body are not at present obtainable.

As regards the improvement of nutrition and increase of weight Boikoff expresses himself as extremely sceptical, and thinks that they more probably follow the altered habits of life pursued under favourable surroundings. He urges too that nearly all physicians prescribe a different dietary along with the koumiss.

Koumiss is rather poor in solids, since these do not reach 5 per cent. Boikoff even found in the winter koumiss prepared in St. Petersburg only 4·5 per cent. Comparing the quantities of albumen, fat, and carbohydrates found in koumiss with those necessary for the maintenance of the bodily equilibrium, he found that not more than a third of this quantity was contained in five bottles, the greatest deficit being in the fat.

To test closer the physiological action of koumiss on nutrition Boikoff instituted a course of experiments in which he ascertained the excretion of nitrogen during its use. A course of similar observations was made with cow's milk.

The experiments were performed on a healthy young medical man, 24 years of age and 62 kilos. in weight, during the winter. He was

most favourable terms of the results. In the second half of this century the first establishments were opened in the Steppes, and soon after endeavours were made to prepare koumiss from the milk of Steppe mares elsewhere and from that of other animals.

supplied with two-day koumiss, which Boikoff obtained from an establishment not far from St. Petersburg, where it was prepared from the milk of Steppe mares. This author believes that the difference between summer and winter koumiss is one of quantity only, and that his results would hold equally good for the summer koumiss of the Steppes. Winter presented one great advantage as regards experiments, that any loss of nitrogen through free perspiration was avoided. He took five or six bottles of koumiss with a little white bread. His diet was, as regards its constituents, about what was necessary to subsistence in a healthy individual.

Three series of observations were made with koumiss and three with cow's milk. Each course lasted from four to six days, during which the total nitrogen in the urine and fæces was estimated, and that in the food was also ascertained each time by burning with soda lime. Besides this the rate of respiration and pulse, the temperature of the body, and the results of the analysis of the urine were all recorded.

Boikoff observed that after taking the koumiss there was always an eructation of gases, without any oppression being felt in the stomach, unless the doses had been very large. The feeling of satisfaction after a bottle and a half of koumiss and $\frac{3}{4}$lb. of white bread did not last over three hours. With six bottles, each containing 700 grammes, the appetite was so good that the subject of experiment would take 12,000 grammes of bread besides. The bowels yielded quite regularly a daily evacuation, very slightly coloured and firm, the weight of which when dried was about 38 grammes for the 24 hours. As to the action of koumiss on the nervous system, Boikoff found, like other observers, a slight stimulation during the first hour, after which a sensation of languor and inclination to sleep set in. Sleep was sound and refreshing. The most striking results were seen in the secretion of urine, the quantity of which increased from the first day. The urine was transparent, pale, without sediment, with a specific gravity of 1,007 to 1,010 and feebly acid reaction; indeed, the acidity was about one-third only of the normal. The volume of urine passed increased regularly with that of the koumiss drunk, as a rule 80 per cent. being passed by the kidneys. At the same time the excretion of urea rose 25 per cent., while sodium chloride was present in the urine in diminished amount (2 to 3 grammes); the phosphates remained unchanged; the proportion of uric acid seemed reduced.

In the first period the effect of the koumiss was seen in an acceleration of the pulse by 8 to 10 beats in the minute, but later the pulse again returned to the normal rate, though it remained fuller and softer. The capillaries were surcharged with blood, producing a flushing of the face. As regards the respirations Boikoff could detect

no change; the temperature too showed the same daily fluctuations as under normal conditions. The body weight increased in all three series of observations by 0·5 to 1 kilo., but the gain was soon lost [water ?—TRANSLATOR]. The skin was moist, but really profuse perspirations were not at any time observed.

The control of the intake of nitrogen with the food, and of the nitrogen excreted with the urine and fæces, was in the first experiment continued for six days, during which it appeared that 1 gramme of nitrogen was retained in the body daily. In the second experiment, conducted under the same conditions, the difference between the intake and output was only 0·5 gramme daily.

In a comparison of his own observations with those of Genth, who introduced large quantities of water into the system, Boikoff finds a great similarity in the results. Genth, after the administration of large quantities of water, invariably noticed an increased excretion of urea and a lessened production of uric acid. In Boikoff's opinion the primary action is an intensification of the albuminous metabolism, without, however, any prejudicial effect on the organism. The retention in the body of an appreciable amount of nitrogen is adequately explained by the excess of albumen and of fat contained in five bottles of koumiss and a kilogramme of white bread.

The parallel experiments with cow's milk in nearly the same doses, but accompanied by a somewhat smaller quantity of bread, induced a marked oppression of the stomach and disturbance of the functions of the intestine, shown by gurglings in the bowels, meteorism, and frequent evacuations. Dryness of the mouth and loss of appetite were observed. The volume of the urine corresponded to that of the water taken in the forms of milk and tea. Its specific gravity was higher, 1,012 to 1,015, and its reaction more strongly acid than with koumiss. The urea excreted exceeded the normal by 40 per cent., and the phosphates were increased by about 1 gramme daily. As with koumiss the chlorides were diminished; the quantity of uric acid was not less. Only very large doses of milk produced any acceleration of the respiration or of the pulse (2 to 4 beats). The evening temperature was higher than the normal. The greatest increase of body weight, after a five days' use of 3,700 ccm. of milk with 835 grammes of white bread, reached only 385 grammes in the first course of experiment, 170 grammes in the second, and 280 grammes in the third. The retention of nitrogen, was, however, more considerable than under the koumiss diet; there were, on the average, three grammes less excreted than introduced.

A further difference in the course of albuminous metabolism with koumiss and milk diets is rendered evident by the accompanying table, viz. that the assumption of nitrogen during the former was greater on each successive day, whereas during the latter it became daily less.

Day	Nitrogen					
	Milk Diet			Koumiss Diet		
	Intake	Output	Difference	Intake	Output	Difference
1st	30·711	24·176	+ 6·535	22·257	24·974	− 2·717
2nd	30·356	25·113	+ 5·243	23·560	22·673	+ 0·887
3rd	30·946	27·432	+ 3·514	23·362	22·056	+ 1·306
4th	31·244	28·746	+ 2·498	23·177	21·123	+ 2·045
5th	30·820	30·124	+ 0·696	25·198	22·757	+ 2·471
6th	—	—	—	23·992	22·825	+ 1·167

Boikoff is positively convinced that koumiss is so easily digested owing to the presence of carbonic acid, lactic acid, and alcohol, and that this is the reason why it is so much easier to practise a koumiss diet than a milk diet. Its effects on the organism also testify to its digestibility, since no sensation of weight is perceived, although the quantity of nitrogen retained in the body is less than in the milk diet. [But had the latter been persevered in for several weeks, as the koumiss cure is, there would probably have been a loss, judging by the figures in the table just given, where it appears as if the nitrogen retained had nearly reached zero and might soon have become a minus quantity.—Trans.]

Since the quantity of nitrogen retained in the body corresponds to no more than 30 grammes of albumen, the increase in the body weight can be due only in part to a gain of albumen. The difference between the fluids imbibed and excreted is also very small, so that in the opinion of Boikoff there remain only the fat and carbohydrates, whose retention in the organism can condition the increase of weight: in other words, it must be in great part due to storage of fat.

Among the most important advantages presented by koumiss Boikoff reckons the absence of the evening rise of temperature, observed during the use of like quantities of cow's milk.

In conclusion Boikoff lays down the following propositions:—

1. The use of huge doses of koumiss (as many as five bottles daily) is not necessary for therapeutic purposes, and it is more rational to give smaller.

2. Along with the koumiss a mixed diet and one rich in carbohydrates should be prescribed, as being more advantageous than the nearly exclusive use of meat.

3. The winter koumiss, although distinguished from that of summer by a somewhat smaller proportion of solids, is nevertheless perfectly available for medical use.

4. There is no reason whatever to prohibit the employment of pharmaceutical preparations during treatment by koumiss.

5. The general nutrition of the organism is improved by the prolonged use of cow's milk in a higher degree than by that of koumiss.

6. The high price of mare's milk makes it highly desirable in the interests of patients of moderate means that establishments should be opened for the preparation of koumiss from cow's milk.

Herzenstein,[1] who in describing the chemical constituents of koumiss quotes especially Biel and Stahlberg, is of opinion that koumiss improves the general nutrition by providing a nutritive material (casein) in a form easily ingested and speedily assimilated, while alcohol and carbonic acid, from their preservative properties, tend to diminish waste. Thus it is that the use of koumiss leads to a storing up of materials in the body.

The preparation of koumiss needs, according to Herzenstein, great experience and practical knowledge; the fermentation occurring therein belongs evidently to those capricious processes which often go wrong in spite of all precautions, so that it is hard to say why the mucous or the butyric has been set up instead of the vinous fermentation. According to Herzenstein cleanliness is the most important condition in the preparation of koumiss, as, indeed, is observed in all the establishments. He condemns any form of falsification, but as a matter of fact he finds the addition of water when milk is scarce the only likely one. But such a want becomes every year more and more felt, since open pasturages become ever less, the price rising and the nomads withdrawing farther east. Besides it is difficult to get milch mares of good breeds, and Herzenstein himself has seen common Russian mares, much exhausted by work, employed in place of those of the Steppes.

[1] Herzenstein, *The Koumiss Establishments of the Volga Country, with a Dissertation on the Chemical Constituents of Koumiss and the Indications and Contra-indications to its Employment* (Russian). St. Petersburg, 1880.

The writer of this very learned *brochure* describes the impression which an inspection of the ten koumiss establishments in the governments of Ssamara, Orenburg, and Ssaratow had made on him. He has had no personal experience of and no intimate acquaintance with koumiss, but, having great theoretical belief in this treatment, he wished to indicate to the public and the profession where and how to avail themselves of the koumiss cure. He remarks on the very superficial acquaintance of Russian physicians generally with this branch of therapeutics, although the treatment has in numerous diseases many advantages over mineral waters and other health resorts. Of the existing institutions the author has a very gloomy impression, as being defective both in their medical and domestic resources. The majority of patients who frequent these places suffer from diseases of the lungs or pleura, or from various forms of anæmia or catarrhs of the digestive organs. The examination of patients by the physicians Herzenstein finds too superficial; especially is the analysis of the urine neglected and diseases of the kidney overlooked, though they are among the most important contra-indications, and the writer has known several such patients seriously injured by the treatment. Its prejudicial effects in these diseases were early recognised.

The limiting of the pasture lands by the country being more cultivated, and the difficulty of getting milch mares, have prompted several speculators to try a reduction of the doses while seeking advantage in meat diet, better quarters, &c. If these difficulties be not overcome in some way the koumiss cure will have to be abandoned.

Of special dietetic rules Herzenstein heard nothing; the diet was generally bad, consisting chiefly of mutton, which certainly is digestible but soon becomes disliked. The management of most institutions was bad in the extreme; the patients enjoyed few comforts, and every trifle had to be extorted by a struggle, a serious consideration with a number of irritable and sick persons. Most of the establishments are, however, well situated, securing the dry air from the Steppes; but those on the Volga are exposed to malarious exhalations. He did not see in any of these buildings the epidemic diseases, as malaria and dysentery, noticed by Ukke, a fact he considers due to hygienic improvements in the circumstances of the inmates. Statistical evidence shows that malaria and dysentery prevail mostly in the summer.

Deaths from lung diseases form but 7·2 per cent. of the whole mortality, a very small number compared with other countries. Herzenstein considers the climatic conditions of the district of Ssamara very favourable.[1] The life of the patients being entirely occupied with the healing drink, everyone keeps to himself as much as possible, and this business is interrupted only by dinner and sleep. It is thus clear that the essential advantages of the koumiss cure in these places are to be sought rather in the country—that is to say, in the climate.

Herzenstein, in common with all other writers on the subject, looks on koumiss as a highly nutritious substance, the easy digestion of which, combined with a stimulating and then calming action, makes it one of the most effective of all foods. It is, then, not to be wondered at that one should meet persons who have gained 4 kilos. in $1\frac{1}{2}$ to 2 months. The employment of koumiss appears indicated first of all in that large group of derangements of the general nutrition—anæmia, chlorosis, scurvy, scrofula, rickets, diabetes (at least on theoretical grounds), as well as in convalescence from grave diseases, in debility after abuse *in Baccho et Venere*, morphinism and mercurialism. The writer further recommends the use of koumiss in the adynamic period of typhoid, and believes that it might be tried in cholera on the strength of the very successful results achieved by Devolf in the so-called cholera infantum. Koumiss has received great praise in chronic catarrhs of the stomach, and it is well borne even in cancer of that organ. Of

[1] Lodgings are rather cheap but dirty; the closets especially are wretchedly arranged. Ventilation is very good, because the windows, thanks to the warm climate, are kept open all day. There are baths in almost all establishments, but slovenly kept.

all diseases of this group there is only one in which its acidity contra-indicates it, viz. circular ulcer of the stomach. In the class of respiratory diseases koumiss plays a great part, and Herzenstein ascribes to it over and above its nutritive value a specific action on the mucous membranes, the secretions being increased and a slight irritation set up. Chronic bronchitis is thus rapidly and radically cured by koumiss. Consumption is not cured, but the strength of the patients is maintained, the fever lessened, and a number of concomitant symptoms removed, especially catarrhs of the bronchi and of the digestive organs, and thus a great influence for good is exerted on the general condition. Only copious hæmoptysis and a high temperature contraindicate it. Its beneficial effects in emphysema are also due to the relief of bronchial catarrh. Koumiss has, on account of its diuretic and diaphoretic action, great influence in the removal of pleuritic effusions. [The diuresis, &c., appear to be no more than the removal of the excess of water ingested in the form of the koumiss itself, and consequently any influence on pleural effusions, &c., is more than doubtful.—TRANS.] In diseases of the heart not involving the valves it has been found useful. Cases too are described of the cure of chronic urethritis and leucorrhœa. Among diseases of the nervous system those only can be successfully treated which are unaccompanied by any organic changes in the brain.[1]

Koumiss is obviously contra-indicated in general plethora and any tendency to apoplexy. In abdominal plethora Herzenstein and almost every authority except Postnikoff are opposed to its employment. In acute febrile disease few physicians would give it, but this has no bearing on the exhausting fever of phthisis, diseases of the bones, &c.

Herzenstein does not think pregnancy any contra-indication, having himself seen a pregnant woman with infiltration of the apices who bore the treatment very well. Koumiss is, however, unsuited for renal calculus and hyperæmia or inflammatory conditions of the kidney, and absolute contra-indications are presented by organic diseases of the heart and pericardium (excepting scrofulous pericarditis), as well as aneurism and inflammation of the arteries. Chronic metritis and oophoritis are indeed held to be contra-indications by some, but further observation is wanted in this direction.

It is clear that when there is an obstruction to the flow of blood through the liver, as well as in inflammations of this organ, koumiss

[1] It is but right to observe here that this part of his work, as well as that which follows on the contra-indications, is entirely based on published records and theoretical conclusions.

may act very injuriously, since it must increase the mass of the blood and the alcohol acts as a stimulant.

Herzenstein insists on the necessity of prescribing the particular kind of koumiss, since the weak form will generally cause a liquid stool, while the stronger often tends to constipation. It is not possible to fix a limit to the treatment: it should be drunk as long and as much as possible. As to the disputed question of the advantages possessed by the Ssamara district, whether as regards climate or pasturage, he is in favour of the Steppes. Koumiss in and by itself demands no particular diet; this must be determined by the state of the stomach. It is advisable not to take any large quantity of fluids, so as not to limit the consumption of koumiss. There is sufficient alcohol in koumiss to render the use of other alcoholic drinks inexpedient.[1]

Schermasanoff [2] sees in koumiss a nutritious food, but considers a six weeks' course quite insufficient; it should be drunk as long as possible. Without denying the utility of the koumiss cure in other places than Ssamara he gives the preference to the Steppes. He estimated the proportions of fat and of sugar in mare's milk, and his figures closely approach those of Biel, for he found the sugar to be 6 per cent. and the fat 2·9 per cent. He further insists on the necessity of making a distinction between the weak and the strong koumiss, the latter containing more alcohol, carbonic and lactic acids, but less sugar than the weak.

The diet during the koumiss cure should be plain; alcoholic drinks and fat foods should be avoided. Beginning with small doses gulped down, one may rise to 6 or 10 bottles daily if so much can be borne. The effects of the treatment are best seen in the gain of weight.

The figures furnished by Schermasanoff show a gain of 2 kilos. in a week while the patients were drinking on an average 5 bottles daily. Eight patients exhibited after two months of the treatment an enormous increase of weight, amounting to as much as 11 to 13 kilos., while they had drunk from 5 to 10 bottles daily. The writer himself drank as many as 7 bottles a day for 3½ months, and his weight increased 7 kilos.; during the

[1] At the end of his pamphlet Herzenstein describes the best koumiss establishments, having previously dwelt more on their defects than on their merits. In the most celebrated—those of Annaeff, Postnikoff, Chembubatoff, and Ustinoff—the living, including koumiss, costs about 15*l.* monthly, but there are others where one can exist on 6*l.* a month.

[2] Schermasanoff, 'On the Practice of the Koumiss Cure,' *Journ. of Hydrotherapy*, 1881, No. 1 (Russian). This author has for several years been practically acquainted with koumiss, and is pleased to find it beginning to take its merited place in therapeutics, but laments at the same time that koumiss establishments scarcely pay at all. The number of patients who resort thither yearly he estimates at about 1,500. He names as the best those of Annaeff, Postnikoff, and Chembubatoff, all not far from Ssamara.

following winter he lost 3 kilos., which he recovered in the next summer. The greatest increase of weight observed by him amounted to 14 kilos. When effusions are present an improvement of the health may be attended by a loss of weight, consequent on the absorption of the fluid.

The effects of the koumiss are seen in several ways; the elevated temperature falls; respiration is at first accelerated, but afterwards becomes less frequent and deeper. Weak koumiss and mare's milk set up diarrhœa, but the strong tends to constipation. Large doses produce a degree of intoxication, which soon passes into an inclination to sleep. In June and July, when the Steppes are parched, the koumiss is not so rich in fat as in the spring. In the selection of the several kinds of koumiss the writer recommends that regard be had not merely to the day, but to the number of hours that fermentation has been in progress; thus on the second day there is a difference of twelve hours between the morning and evening. When diarrhœa occurs a little cognac should be added to the koumiss.

Since koumiss is essentially a nutritious drink which aids the solution and absorption of the products of inflammation, it is indicated in exhaustion of every kind.[1] It is very effective in scurvy, scrofula, and rickets. In bronchial catarrh a liquefaction of the sputa, with easier expectoration, is observed no less than an improvement of the nutrition. In the treatment of consumption koumiss presents an invaluable remedy; for even though one cannot hope for a radical cure one may often see surprising improvement: the fever disappears, the strength returns, and the destructive process is arrested. The writer adduces a whole series of cases in which, notwithstanding undoubted chronic pneumonia with infiltration of the apices of the lungs, high fever, and repeated hæmoptysis, the patients gained several kilos. in weight, the temperature became normal, and only the percussion signs persisted. Very many cases of gastric catarrh were also cured by koumiss. The absorption of pleuritic effusions was frequently observed. Chronic urethritis and leucorrhœa yielded to it in like manner.

A very interesting case is one of hystero-epileptic attacks, developing in a young consumptive woman in consequence of vaginismus. The patient was entirely freed from the attacks, the cough relieved, and her weight increased by 5 kilos.; but the temperature did not become normal and reached 100° F. in the evening. The patient went through the treatment for three seasons.

[1] A woman who after nine pregnancies had become extremely exhausted and presented a very low state of nutrition gained during a six weeks' course, with a daily consumption reaching four bottles daily, four kilos. in body weight.

Pregnancy does not contra-indicate koumiss; in support of this view the writer refers to several cases, but in diseases of the heart, great vessels, and kidneys it is inadmissible. The majority of the patients go as far as five bottles, and the instances of larger doses, as ten to fifteen bottles, are exceptional.

Karrik[1] undertakes in his work 'On Koumiss' a discussion of its chemical properties.

On the strength of observations made by his predecessors Karrik says that mare's milk is much poorer in albumen and fat than woman's milk, and far more so than cow's, but in respect of sugar it stands midway between these two. But a qualitative difference has also been established between the properties of the casein of these milks, that of woman and the mare being much more soluble in lactic acid, forming a light flocculent deposit, which, when dry, has a pale colour and dissolves easily in distilled water. Neither gastric juice, acetic acid, nor carbonic acid throw down all the albuminates from mare's milk, and only by heating with neutral salts, as Glauber's salts or sodium chloride, is the whole of the casein precipitated. The fat of mare's milk is marked by a very soft consistence; the sugar too appears to be more easily broken up in fermentation, since that process sets in very quickly. This consists in the conversion of the milk sugar into alcohol, carbonic acid, and lactic acid. At the same time the greater part of the casein is precipitated, though a small part remains dissolved in the whey. The quantity of the albumen and lacto-protein, at the expense of which the fermentation takes place, is somewhat diminished. In decomposition with yeast (Penicillium glaucum and Torula cerevisii) the lactic acid fermentation is succeeded by alcoholic fermentation, and when this has reached a certain

[1] Karrik, 'On Koumiss,' *The Physician*, 1881 (Russian). The author depicts most graphically the Steppes of South-Eastern Russia, with their sandy soil, with their clear continental climate, with severe winters and hot, dry summers, the rich pastures where herds of horses, sheep, and camels graze. He describes the winter, fertile in hardships, hunger, and disease to the nomads, and the lovely summers, which quickly restore their health, thanks to the air of the Steppes and the abundance of mare's milk that they drink in a fermented condition as koumiss. This fact had long come under the notice of travellers and served to introduce koumiss into medicine. The history of koumiss is very ancient, for even in Herodotus there are indications of its preparation by the Scythians. Then many travellers, from the eleventh century onwards, describe it as a spirituous drink. The first serious work on koumiss was that of John Grien in 1788; then there exists a mass of statements about it in various journals by persons who have never seen it. Only since Postnikoff opened the first establishment have any serious works on koumiss appeared, and the chief subject of all these is a general assertion of its nutritive and therapeutic properties. Those authors only who have never seen koumiss in its own place venture to doubt its value, and among them he reckons Boikoff, who drew some very remarkable conclusions as to its action from observations made on a healthy man.

point the former ceases, the alcoholic continuing alone. The latter is aided by frequent stirring, through the readier access thus given to the oxygen of the air. This procedure, according to the doctrine of Pasteur, tends to prevent the development of the butyric fermentation, oxygen being fatal to the vibrios that excite this change. It has been noticed that the fermentation is the easier set up the richer the milk is in fat. But the most remarkable chemical phenomenon in the fermentation of mare's milk is the change in the solubility of the casein; that which had already been thrown down begins again to dissolve, the quantity of redissolved casein reaching 13·5 per cent. on the third day, and 35·5 per cent. on the sixteenth. The change in the milk sugar proceeds very fast at first. Thus in the first twenty-four hours two-thirds of the whole quantity will have disappeared, after which it goes on very much slower.

For the manufacture of a proper koumiss good mare's milk is the first requisite. This should be rich in sugar and fat. To obtain such a milk the nomads never put the mares to any labour, and for eight months they enjoy the fresh air and rich pasture of the Steppes. During the winter, however, they are exposed to hunger and cold, and the weaker animals succumb. The frequent milking of the mares, viz. four to eight times daily, tends to reduce the quantity of fat. The act of milking is attended with some difficulty, for the sphincters of the udders are strongly developed, and the mares yield milk only in the presence of their foals, which are therefore allowed access to the dams at night. Sometimes the mares have to be fettered. It is absolutely necessary that they should belong to the Steppe breed, that has for long been employed exclusively for milch purposes, since only such yield a milk rich in sugar, and the pasture of the Steppes is equally essential.[1] In addition to good pasture there must be plenty of good water at hand for drinking and bathing, and salt must be given to the mares to lick. Only when all these conditions are fulfilled can one get really good milk.

In the preparation of koumiss Karrik lays special stress on cleanliness, and also considers frequent stirring and a uniform temperature of from 73° to 90° F. to be important. Good koumiss is very palatable, of a pleasant acid taste, and smells of the aromatic Steppe plants. The strong kind is thinner, sourer, and richer in carbonic acid than the weaker.

Karrik confirms nearly all the observations of Poloubensky, Seeland, and Postnikoff on the physiological action of koumiss, and lays great stress on its nutritive value and high digestibility, explaining the last by the presence of carbonic acid, lactic acid, and alcohol. Koumiss is digested with remarkable rapidity, and is almost completely absorbed; the dejections are scanty, pale-coloured, and odourless, and there is a tendency to constipation; only the weak koumiss

[1] Besides the Stipa pennata, which for a long time has ceased to be found everywhere, good pastures are rich in the following plants: Artemisia absinthium, Achillea millefolium, folium serum [*sic*], draba, sinapis, origanum, thymus, mentha, salvia, galeopsis, veronica, plantago, alchemilla, geum, potentilla, malva, althea, ranunculus, senecio, delphinium, briza, scabiosa, euphorbium, &c.

at first leads as a rule to three to five liquid evacuations daily. Soon after the commencement of the treatment the author noticed an increase of five to ten beats per minute in the frequency of the pulse, and the respiration to be somewhat accelerated; but these symptoms soon gave place to the normal condition. Later on the heart's beats were stronger, the pulse fuller, and the cutaneous capillary network more filled with blood, giving a ruddiness to the complexion. On the temperature of non-febrile patients koumiss has no effect.

The intoxicating effect of koumiss is very slight and never produces headache, which is probably owing to the purity of the alcohol, the action of which, as in champagne, is aided by the carbonic acid. The excitement of the nervous system soon passes into a desire for quiet and for sleep, due to the alcohol and lactic acid. The writer confirms the diuretic and diaphoretic action, and quotes the analyses of the urine by Biel and Boikoff, remarking on the increased metamorphosis of tissue. He admits that koumiss in and by itself is not sufficient for the requirements of the organism, which even ten bottles cannot satisfy, on account of the small proportion of carbohydrates.

The therapeutic action of koumiss shows itself in the improvement of the general nutrition, and even a feeble and diseased stomach will digest large quantities of koumiss; the tongue becomes clean, heartburn ceases, the appetite increases, and the patient is able to digest any kind of food. The appetite becomes specially great in persons who have previously suffered from indigestion and in consumptives. Abnormal frequency of the pulse due to anæmia or to fever usually disappears under the use of koumiss. The dry, short cough of consumptives is relieved in a remarkably short time, the sputa becoming fluid and expectorated with ease. From his own observations Karrik cannot think that koumiss has any tendency to excite hæmoptysis. This symptom does not occur more frequently during the koumiss treatment than without it, since the vessels sharing in the generally improved strength are better able to resist the increased pressure of the blood. The exhausting sweats of consumptives become less and frequently cease altogether. Sleep is uninterrupted and deep; menstruation occurs more freely and regularly. The increase of strength is very conspicuous in anæmic and phthisical subjects; their weights increase and their figures become fuller, which cannot be mainly due, as has been supposed, to a mere deposition of fat, or the muscular power could not be so raised as it actually is.[1] The author has himself observed the results of koumiss

[1] Karrik adduces several examples of enormous increase of weight in consumptives; some he has seen who have gained as much as six kilos. These cases are, it is true, only exceptional.

treatment in anæmia, gastric catarrh, and consumption, but does not doubt that other diseases attended by exhaustion would be either entirely cured or arrested in their course. Cases, indeed, have come within his knowledge of gastric and intestinal ulcers successfully treated by it. Very good results were obtained in scurvy, scrofula, and syphilis. In one case of Bright's disease, that of a man who had had albuminuria for three years, Karrik saw what seemed to be a very successful result of koumiss treatment, the albumen permanently disappearing. He would attribute this to the flushing out of the urinary tubules with water, the diuretic and diaphoretic action of the koumiss, combined with its influence for good on the general nutrition. From the successful results of the treatment of diabetes mellitus with lactic acid by Cantani the author advises the trial of koumiss in a number of future cases. Karrik saw also several cases of valvular disease of the heart in which koumiss was very useful; this he explains by the strengthening of the substance of the heart itself and the improvement of the blood; and, in opposition to all other authorities, he declares that heart disease is no contra-indication to its use.

Karrik devotes a special chapter to the treatment of consumption by koumiss. Under phthisis he includes all diseases of the lung in which solidification and destruction of the parenchyma can be proved. He next brings forward a number of highly interesting accounts, taken from reports of the military surgeons, which relate to the cases of over a thousand officers and men, mostly suffering from chest affections, for which the Ministry of War had opened a koumiss establishment not far from Ssamara. The reports cover a period of several years, and we get the following figures: In the course of six years the number of patients reached 993; of these, 551 were cured or greatly improved, in 314 there was a material alleviation, and 128 remained in the same condition, grew worse, or died. Of the 993 patients, 866 were cases of lung disease. The increase of weight in 660 cases reached an average of 4 kilos., the maximum gain being 12 kilos. in six weeks.

Karrik regrets that the majority of observations to be found in the literature of the subject relate to single seasons only, the further progress of the disease being rarely recorded. He contributes 25 cases of phthisis which he had watched for longer or shorter periods. In nine of these there was a great increase in weight, and perfect recovery was attained, so that the patients were enabled to resume their former occupations; in five there was great relief, but their condition made a repetition of the treatment necessary; in six there was some relief obtained through the koumiss, but they succumbed after some time to phthisis, a few almost immediately. In the course of one to ten years eleven died of the twenty-five; among the fourteen survivors thirteen were living five years after having gone through

the cure. The mean gain of weight among the whole twenty-five was 5 kilos. They were all well-marked cases of phthisis, with solidification and breaking down of the apices, moist crepitant râles, fever, and night sweats. The writer then gives the history of persons still living who, in their youth, had had hæmoptysis, fever, emaciation, and night sweats, with solidification of the apices. All were cured by koumiss, and three of them (Professors Manassein, Lesgaft, and Owsjarnikoff) are now lecturing without the least inconvenience. He quotes also several cases of cure of consumption on the authority of other observers, some of whom the writer had recently seen in good health.

From the observations of this writer koumiss would appear to be contra-indicated in plethora, hyperæmia of the brain, liver, and spleen; in overfilling of the pulmonary circulation, in aneurisms and degeneration of the arteries, and in acute and chronic rheumatism. On the occurrence of hæmoptysis it should be prohibited, and after its cessation should be resumed only in the weaker form and in small doses.

Koumiss should be drunk warm, about the temperature of the room, and in the largest doses possible without overfilling the stomach. It is especially important in phthisis, when emaciation is considerable, to administer as much as can be assimilated. That of medium strength is most used, but replaced on the appearance of diarrhœa by the strong, or in constipation by the weak or by unfermented mare's milk.

Although Karrik acknowledges the value of koumiss made elsewhere, he gives the preference to that of the Steppes, since the curative influence of the aromatic, clear, dry air of the summer at Ssamara is not inconsiderable. He says that the treatment of consumptives on the Steppes should be undertaken during the summer, and should extend over at least two months. The climate presents the advantage of enabling the patient to drink such quantities as he could elsewhere only on very hot days. Anæmic subjects and those with diseases of the stomach may employ the koumiss cure with benefit in other places and at all seasons of the year.

Karrik further advises consumptives to ride regularly on the Steppes, since their strength is greatly improved thereby, although the weight gained may be somewhat less. Among the advantages of the Steppes he reckons also the methodical course of life and the freedom from anxiety and work. The diet, meanwhile, should be a varied one; only such foods and drinks as quench the thirst should be avoided, so that the more koumiss may be drunk. One ought never to send cases of acute tuberculosis to the Steppes, since success is very doubtful in rapid extension of the process. Nevertheless he reports two cases of successful treatment of this disease. A young girl of nineteen years, whose brother and sister had died of galloping consumption, had one autumn a severe attack of hæmoptysis; in winter she emaciated fearfully and suffered from night sweats, cough, and dyspnœa, and the hæmoptysis recurred. In the spring her condition seemed hopeless; she was unable to walk, and

in this condition, when Postnikoff diagnosed a large cavity and solidification of both upper lobes, she began the koumiss cure. She remained there the whole summer, and drank koumiss also in the following winter; in the meantime she gained 7 kilos. in weight, and her strength so far returned that she could not only walk, but even dance, although subcrepitant râles were audible under both clavicles. The patient lived for two and a half years from the commencement of the koumiss cure. Another case is still more remarkable. A young professor of thirty-one years was attacked with hæmoptysis, after which hectic fever, cough, emaciation, and dyspnœa supervened. On examination resonance was found dull beneath both clavicles, with crepitant râles. After eight weeks' koumiss cure the patient could scarcely recognise himself. He had drunk up to five bottles daily when improvement at once appeared; the fever had subsided in the second week, and he gained 6 kilos. in weight. At the end of the course weak vesicular breathing was audible under the left clavicle, but dulness and subcrepitant râles remained under the right. Sonorous rhonchi disappeared after three months. The patient passed the following winter and spring in Italy, and is now quite well. This and other cases convinced Karrik that in the first place fever is no contra-indication to the use of koumiss, and in the second that hereditary cases are harder to cure than others. In ulceration of the larynx koumiss is taken with difficulty because the carbonic and lactic acids irritate the ulcerated surfaces. In severe cases of phthisis the patients should be sent during the following winter and spring to the South, and they should resume the koumiss cure in the Steppes next summer.

After having given the opinions of different authorities on koumiss and koumiss cures, so far as they appear to be of any value, I shall report my own observations, which I have already published in a treatise on this subject.[1] I have in my report shortly reviewed the

[1] 'Report on the Koumiss Cure by Annaeff on the Datscha for the Season 1881,' *Journ. of Hydrotherapy*, 1881, No. 11 (Russian). The author passed the summer of 1881 in Annaeff's establishment, where he undertook the superintendence of the medical and hygienic department. Wishing to observe the physiological and therapeutical action of koumiss, he directed special attention to its preparation, to the choice of mares of the Steppe breed, to cleanliness in its manufacture, to the prevention of falsification, to the accurate selection of the different strengths, &c. Together with the principal he spared no pains to ensure good quarters and table for their patients; a task so much the easier, as Annaeff's is one of the best and wealthiest of these establishments. In this season there were more than a hundred patients in the place, sixty-two of whom were subjected to close clinical observation. He shared the wish of the Russian physician to extend the employment of the koumiss cure, since so many patients are sent away to take foreign mineral waters, the action of which can in no way be compared to that of koumiss. The therapeutic action of koumiss most nearly resembles that of the waters at Ems, although, of course, these have no nutritive value.

Annaeff's establishment stands on a hill on the bank of the Volga, three versts distant from Ssamara. It is surrounded by a park and is well arranged,

establishment of Annaeff, the preparation of koumiss, and its physiological and therapeutic action partly on the strength of the information contained in the literature of the subject and partly on that of my own observations.

The chemical process in the manufacture of koumiss consists in the conversion of the milk sugar into alcohol, carbonic acid, and lactic acid. I performed several analyses, and found that the figures differed but little from those of Biel and Gartié; from these I calculated what amount of nutritive materials were ingested with an average dose of five bottles daily. Of two-day koumiss I found that 111 grammes of albumen, 58 grammes of fat, and 70 grammes of milk sugar, besides 31 grammes of lactic acid, 79 grammes of alcohol, and 16 grammes of salts, were contained in the five bottles. These figures, when compared with the numbers given by Moleschott, show that koumiss by itself is no luxurious fare and that the five bottles contain only $\frac{5}{6}$ of the albumen, $\frac{3}{4}$ of the fat, $\frac{1}{2}$ of the salts, and but $\frac{1}{5}$ of the carbohydrates necessary for health. The impossibility of living on koumiss alone is evident, and it is easily understood why the appetite is not lost during its use and fat mutton plays so important a part in the dietary of the nomads. But though a koumiss diet is insufficient from a quantitative point of view it excels every other qualitatively; the casein is in

with libraries, attached verandahs, theatre, carriages, &c., and the table is good. The climate of Ssamara is somewhat warmer than one would expect from its geographical position. The Gigulöff Mountains, which play a great part in the climatology of this district, rise about fifteen kilometres to the north Ssamara lies under the 53° of north latitude and 5° of longitude E. from Greenwich. The mean temperature of the year is 41° F. In May the mean is 61° F., in June 66° F., in July 72° F., and in August 61° F. These figures, taken from Ukke, are somewhat lower than those observed by the writer. The diurnal variations do not exceed 46° F. [!]. These facts justify the claim of Ssamara to a uniform and warm climate [?]. Rain falls on an average on one day in three, but is of short duration and small in quantity. The air is dry, the winds are mostly west, south-west, and south. The writer agrees with Ukke in considering such a climate well suited for the treatment of chest diseases. The milch mares are obtained from the Bashkirs for the summer, but some belong to Annaeff himself. They graze either on the Steppe or are fed on fresh-cut grass from the same. They are milked thrice daily and give each time two to three bottles of sweet milk with an agreeable odour and a specific gravity of 1,033 to 1,036. In very hot weather, when the mares drink freely, the specific gravity is somewhat less. The koumiss is prepared by a Tartar family, who have served the establishment for twenty years, with a scrupulous cleanliness and in the sight of the patients. After one day's stirring it is poured into bottles and kept in the cellar at a temperature of 50° to 60° F. The sorting is strictly observed, a separate part of the cellar being reserved for each kind.

a form most susceptible of digestion, and in a state of fine division, while alcohol, carbonic acid, and lactic acid assist the digestion. The very great influence on the increase of body weight exerted by koumiss is seen in the tables given in the report, which also show that the gain is greatest in cases of anæmia of different kinds and in chronic pneumonia. The weight increases in proportion to the duration of the treatment and the number of bottles drunk; the age of the patient, too, has some influence; for the older he is the greater the gain. This gain cannot be wholly explained by assuming the storing up of fat, for the total quantity of fat taken in during the treatment scarcely equals half the weight gained, while the general condition of the patients, their complexion, and muscular power all point to the better nutrition of the tissues generally.

Koumiss exerts a marked effect on the secretion of urine, for not only is the quantity passed three times as great as the normal, but, though the specific gravity is somewhat lowered, the total solids are absolutely increased, especially the urea phosphates and chlorides. The uric acid is diminished, indicating the completeness of the oxidation processes, and the acid reaction of the urine gives way to a neutral. These changes are indeed very similar to those which take place when large quantities of pure water are imbibed. Koumiss causes no change of temperature in a healthy individual, the daily variations observed not exceeding 2° F. In febrile cases there is often a fall of temperature observed along with the general improvement and depending on the subsidence of the morbid process.

As regards the effects of koumiss on single organs the mucous membrane of the mouth becomes moist and red and the tongue clean. Koumiss has no effect on sound teeth, but caries is accelerated by it, while any traces of it left in the oral cavity speedily undergo decomposition. The sour taste of the drink excites an abundant secretion of saliva; gurglings in the stomach, soon extending over the whole abdomen, are caused by the evolution of carbonic acid and the active peristalsis it excites. Even large quantities of koumiss—as much as a litre—quickly disappear from the stomach, which can be shown by percussion to be empty after the lapse of one hour. Absorption is performed so rapidly and completely in the small intestine that there is little residuum to be found in the large. The large proportion of sugar in weak koumiss and in mare's milk explains their laxative action. The small bulk of the excreta, and the absence from them of anything irritating, easily accounts for the tendency to constipation

noticed by all observers. The alcohol excites the heart's action and the pulse becomes more frequent and fuller.[1]

I, too, have observed the effects so often noticed on the respiratory organs, the increased mass of blood demanding more oxygen, while the distended vessels of the lung reduce the capacity of the thorax, the result of these two factors being seen in an acceleration of the respiratory movements to the extent of 8 to 15 per minute, and later in an increased depth. The high tension of the arteries in the lesser circulation is also indicated by the strong accentuation of the second sound at the pulmonary orifice. The indolent mucous membrane of the bronchi is stimulated by the alcohol excreted through the lungs, and chronic catarrhs are often removed.

I have seen a case of gonorrhœa and cystitis made worse, but one can scarcely assume any irritation of the kidneys by the alcohol, for it is eliminated by them to a very small extent; the lactic acid too passes into the urine in the form of alkaline carbonates, and lastly the large proportion of water in the urine, a consequence of the high arterial pressure, cannot be looked on as in any way provocative of kidney disease. It is impossible to speak of a diaphoretic action of koumiss, for with large potations in a hot climate and in a dry atmosphere free perspirations are not to be wondered at. The diuretic and diaphoretic actions of koumiss depend entirely on the volume of water, though this fact does not in the least stand in the way of its therapeutic employment with this intention. The treatment of chronic nephritis by koumiss has been frequently undertaken of late and with successful results. The free perspiration is also of importance, as Liebig has shown, in aiding the absorption of nutriment from the bowel.

By a comparison of the therapeutic effects of the single constituents with that of koumiss as a whole I came to the following results: The happy combination of easily digested materials with others that excite the secretion of the digestive fluids, and themselves aid in digestion, as well as the possibility of accelerating metabolism by means of the quantities of water imbibed during the koumiss cure; the effects of the active perspiration on the processes of absorption; the speedy and complete elimination of the products of retrogressive metamorphosis—all these properties taken together give to koumiss its therapeutic value. To these we must add a lessened irritability of the nervous centres, due to a greater saturation of the nerve-tissue and to the sedative

[1] In two cases, which exhibited such a sensitiveness to the effects of wine that a single glass caused congestion of the head, flushed cheeks, &c., the same symptoms appeared after the use of koumiss.

action of the lactic acid. It is, then, not to be wondered at if under favourable conditions of climate, and aided by the physical and mental rest enjoyed by the patients, koumiss should give the best results.

In my report sixty-two cases are referred to, of which twenty-seven made a perfect recovery and twenty-four were materially improved by means of the koumiss cure, nine left the establishment no better, one case of acute tuberculosis got rapidly worse, and another died in the institution. Thus in fifty-one of the sixty-two, or 82 per cent., there was either recovery or material improvement, and in the remaining eleven the cause of the want of success lay in the specially severe form of the disease (phthisis florida, acute tuberculosis, &c.) or in the duration of treatment being too short. Among the twelve cases of consumption, there were five of chronic catarrhal pneumonia, with well-marked symptoms of consolidation and ulceration of the lung, elevated temperature, and hæmoptysis. Koumiss could not be given in large doses on account of the hæmoptysis, and consequently the gain of weight was small, viz. 1 to 3 kilos.; the cough became less, and the temperature sank, but the objective symptoms were unchanged. On the other hand, in those cases of consumption in which the process was more of an interstitial character, in which cicatrisation and contraction with the formation of bronchiectasic cavities played the principal part, the improvement was considerable. The symptoms of the bronchial catarrh which accompanies the changes in the lung substance disappeared rapidly, but even in these the objective signs remained unaltered, and in no single instance could I assure myself of the complete healing up of the cavities. In five of the twelve cases hæmoptysis recurred, so that the patients were compelled to use the koumiss sparingly.

Of ten cases of chronic bronchitis seven recovered completely; the râles disappeared, together with the cough, pains, and difficulty of breathing. In the remaining three the bronchitis was associated with emphysema, which obviously could not but persist, and in one other hæmoptysis occurred during the koumiss treatment. The patient was a man, with a narrow paralytic (*sic*) thorax and extreme emaciation, who had previously had several attacks of hæmoptysis. He could bear only small doses of koumiss, and this naturally detracted from the full success of the treatment; yet he gained 2·5 kilos. And lastly the remaining case of bronchitis in which there was only an improvement was a young woman of twenty-two, of a consumptive family, who had frequently suffered from bronchitis, with fever, dry pleurisy, and hæmoptysis. After an unhappy marriage she developed hystero-epileptic attacks, and paresis of the lower extremities, and had, too, a constantly elevated temperature of 104° to 108° F. After a course of koumiss she could scarcely be recognised; she had gained 5 kilos., was quite free from cough, and able to take part in the dancing, but the temperature remained above the normal. During the following winter she took a fresh chill, lost flesh rapidly, high fever and bloody expectoration set in, and she was at length unable to walk. In this condition she came to me, and I found, on examination, only a few dry rhonchi over both lungs, and also the signs of an old pleurisy at

the left apex, moderate dulness, weakened breathing, and vocal fremitus, with slight accentuation of the second sound at the pulmonary orifice. During the treatment several purely hysterical attacks occurred. The great weakness in the legs and increased tendon reflex improved greatly under the use of strychnia. After six weeks' residence in the institute she was so much better as to be able to dance; her weight had increased 3·5 kilos. and the râles had disappeared from the lungs, but the enigmatical elevation of the evening temperature to 38° R. remained.[1]

I have described in detail a case of bronchitis in a scrofulous boy with clusters of large glands in his neck, conjunctivitis, and constant diarrhœa. Within two months he was completely cured and gained 2·5 kilos.

Of six cases of pleurisy five were improved. The sixth, in which there was a large effusion of several years' standing, remained in the same state, and was advised to undergo surgical treatment.

The most brilliant results were achieved in many cases of gastric and intestinal catarrh, the increase in weight reaching 5 to 7 kilos. Especially worthy of notice was one of chronic diarrhœa, which persisted after an attack of epidemic dysentery. For four years the patient had tried different modes of treatment, but the slightest indiscretion in diet invariably brought on the diarrhœa. Six weeks after the commencement of the koumiss cure he had gained 4 kilos., and could take any kind of food with impunity. I have published another case in which a severe gastric catarrh, with morning sickness and complete loss of appetite, enlargement of the liver without ascites, considerable emaciation, constant inability to sleep, and premature sclerosis of the arteries existed in consequence of chronic alcoholism. While under treatment the patient took no wine, sleep and appetite returned, and he gained 2 kilos. in one month.

Of two cases of chronic cystitis one was dependent on a gonorrhœa which was at first increased by the koumiss, but later disappeared. The second case had been very much neglected and had existed for over two years; it remained unimproved.

Anæmic subjects formed the last category, and in these I endeavoured to ascertain so far as possible the original cause in each case. In three it was clearly a malarial infection, and quinine was given along with the koumiss; but the repugnance of the patient to koumiss during the paroxysms presented a difficulty in the treatment. In one case the anæmia was the consequence of profuse epistaxis, the patient was greatly exhausted and suffered also from chorea. Fearing a return of the epistaxis, we began the treatment with only half a glass, and at the end of four weeks only two bottles were reached, but the result was brilliant. The patient improved visibly and gained 3 kilos. in weight. The severe neurotic symptoms also disappeared completely; but the most astonishing results were attained in cases of anæmia dependent on disturbances of general nutrition. The appe-

[1] [There must be a mistake here. 38° R. = 117° F., which is impossible. He doubtless means 33° R. = 106° F., which was her temperature before.—TRANSLATOR.]

tite returned on the first week, and recovery went on hand in hand, and the gain in weight reached 3 to 5 kilos. Then came a case of anæmia induced by frequently repeated parturition—a young woman who in the course of four years had given birth to eight children, and was in a state of extreme exhaustion. In seven weeks her health and strength had been completely restored. The last case was a woman, of 31 years, who had had an attack of typhoid, was then infected with syphilis, and had gone through a course of mercurial inunctions which had set up a stomatitis, the traces of which were still present when she came. This patient went as far as eight bottles daily, and gained 7 kilos. in two months. Her health was perfectly restored. In four litres of urine she excreted 40 grammes of urea.

At the end of my report I mentioned the indications for the koumiss cure and insisted on its efficacy in cases where the nutrition must be rapidly improved. The effect of koumiss on catarrh of the respiratory and digestive organs is so conspicuous that it is not strange that many persons should look on it as a specific in these diseases; but where there are destructive processes going on in the lungs, with frequent hæmoptysis, koumiss is not borne and does no good.

Postscript.—Since my work has not appeared in print until nearly a year later than I at first expected, and several important researches have been carried out meanwhile, I will here give the results of these investigations as concisely as possible.

Dr. Dochmann [1] examined the casein of the Steppe milk and Steppe koumiss, and found that the casein of mare's and of woman's milk presented a finely flocculent mass, of a yellowish colour, which when dried assumed a greyish hue: unlike the casein of cow's milk, this is not completely thrown down by mineral acids, nor by several organic acids, as acetic and tartaric. An excess of acid redissolves the casein of mare's milk, which is never the case with that of cows. Gastric juice dissolves the casein of woman's milk with the greatest rapidity, and of cow's milk most slowly, the casein of mare's milk holding a middle place in this respect. These different properties do not, however, in Dochmann's opinion, justify us in looking on the several forms of casein as distinct chemical bodies, for a mere modification of external conditions serves to make the differences less sharply marked; thus the results of the experiments closely resembled one another when, for example, cow's milk was diluted with water, or sugar added to it, or the casein broken up into finer flocculi, or on the other hand when cream was added to mare's milk. The casein precipitated from koumiss soon begins to redissolve, taking on the character of para-

[1] Wratsch, 1882.

peptone (Meissner); when boiled it does not form a pellicle on the surface, and it is thrown down by a trifling addition of carbonate of soda: this precipitate is insoluble in distilled water, although very easily soluble in weak acids or alkalies. Dochmann precipitated the casein of koumiss by means of a small quantity of phosphoric acid, and boiled the filtrate to separate the albumen. The parapeptone he threw down by neutralisation with carbonate of soda. After the removal of these three constituents he precipitated the peptone from the filtrate by means of alcohol. From the researches of Dochmann it appears that the quantity of casein in koumiss of the third day has been reduced by half, as also the albumen; in place of these one finds in each litre 7 grammes of parapeptone and 5 grammes of peptone. The peptonising of the albumen, as Dochmann has proved, takes place more rapidly when a little pepsin is added to the koumiss, the proportion of peptone being trebled by this means.

Dr. Kostjurin[1] has published his observations on the koumiss cure in Slawuta. This establishment is situated on the border of a vast pine forest, and cannot boast of the best arrangements for lodging and board, and the mean humidity is 74 per cent. (in the Steppes of Ssamara it is only 55 per cent.); the koumiss is, however, of good quality. Notwithstanding these unfavourable conditions Kostjurin observed a considerable gain of weight among the patients, amounting in some cases to 5 kilos. But the chief interest of his work lies in the measurements of the vital capacity, of the force of inspiration and expiration (by the help of pneumatometers), and of the strength of the upper extremities (by the dynamometer). Kostjurin found, by measuring with the spirometer, that after a course of koumiss the capacity of the lungs increased by 50 to 500 ccm., the force of inspiration by 4 to 90 mm., the strength of the right hand by 2 to 20 kilos., and of the left by 1 to 18 kilos. From these observations it is clearly impossible to attribute the increase of weight during the koumiss cure solely to the storing up of fat and water in the body. So rich a nourishment as koumiss presents to every organ a mass of the requisite material. Lastly Kostjurin found an increase in the circumference of the chest of as much as 2·5 cm. and a small increase in the bulk of the hand of 0·5 to 1·5 cm.

In the past summer I undertook some experiments with koumiss, examining the chemical composition of the several strengths and the changes induced in the urine. As a final result of my work, which is now in print, I obtained the following tables, from which it will be seen that the fermentation of koumiss ceases after thirty hours:—

[1] Wratsch, 1881.

	Mare's Milk	Koumiss after 6 Hours' Fermentation	Koumiss after 18 Hours' Fermentation	Koumiss after 30 Hours' Fermentation	Koumiss after 4 Days' Fermentation
Carbonic acid .	—	3·8	6·0	7·0	11·0
Alcohol . .	—	18·5	19·5	30·0	30·0
Lactic acid .	—	3·9	5·6	6·4	6·4
Milk sugar .	51	18·8	16·3	—	—
Albumen . .	23	22·5	22·6	20·0	16·0
Fat . . .	19	18·9	20·0	19·0	19·0
Salts . .	5	4·5	4·0	4·0	4·0

The next table shows the changes in the urine following the koumiss cure :—

No. of Litres of Koumiss Drunk in 24 Hours	Urine Passed in 24 Hours	Specific Gravity	Urea	Chlorides
0	1,100	1,019	25·7	13·0
2	2,000	1,011	34·8	15·6
4	3,140	1,009	48·3	15·7
5	3,000	1,009	49·2	12·0

From a review of my work I come to the following conclusion: The fermentation of the Steppe koumiss is complete in thirty hours, after which the chemical changes are not constant. The medium dose of 5 litres is, as regards fat and albumen, a luxurious diet; the quantity of carbohydrates and of salts is, on the contrary, smaller than Moleschott demands for an ordinary day's work of an average man. Favourable results can only be obtained from the koumiss cure in the Steppes, since besides the employment of a genuine koumiss, a hot and dry climate is absolutely necessary. For the manufacture of a really good koumiss a particular breed of mares is essential, which must be fed exclusively on the Steppe grass, and never be used for labour.

All these conditions one meets with only in the Steppes, where the mean summer temperature is 68° F., the mean humidity 55 per cent., and the mean atmospheric pressure 754 mm.

The ferment of koumiss maintains itself at the cost of the sugar, but so soon as this is destroyed the albumen is probably attacked.

A daily ration of 5 litres *plus* a certain quantity of carbohydrates and salts constitutes a liberal diet, meeting all reasonable requirements (Voit). The twenty-four hours' excretion of urea increases with such a diet: in Ssamara the increase amounts to 100 per cent., while at St. Petersburg it never exceeds 50 per cent.

The temperature of a healthy man is unaffected by koumiss. In

chronic diseases attended by fever koumiss exhibits, in addition to its general action, a lowering of the temperature, which not unfrequently sinks to the normal.

In the first stage of phthisis (consolidation) the effect of koumiss is almost without exception successful; in the second (while the destructive process is still limited) it acts only by improving the general condition; in the third stage (strongly marked destruction of lung-tissue) koumiss is badly borne by the patients, and only in the rarest cases gives any relief.

In catarrhs of the upper division of the alimentary canal the best results are attained, but in those only of the lower division as are associated with chronic diarrhœa.

In cases of anæmia, chlorosis, malarial cachexia, &c., the koumiss treatment effects a radical cure.

[P.S.—An artificial koumiss made from cow's milk is prepared at the works of the Aylesbury Dairy Company under the direction of Dr. Vieth, and is sent out in syphon bottles. It has been pronounced 'exquisite' by the highest Russian authorities, and its flavour is certainly delicious. It differs from the 'genuine' koumiss in its greater stability, the fermentation being greatly prolonged and the transition from the mild to the strong form occupying three weeks instead of as many days, a great convenience to patients living at a distance. I have been unable to obtain any information as to the process employed in its manufacture, that being a trade secret of the company.—TRANSLATOR.]

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END OF THE FIRST VOLUME.

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